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The Engineer

VOL. CLXXII.—No. 4473 28, ESSEX ST., STRAND, LONDON, W.C.2 OCTOBER 3, 1941

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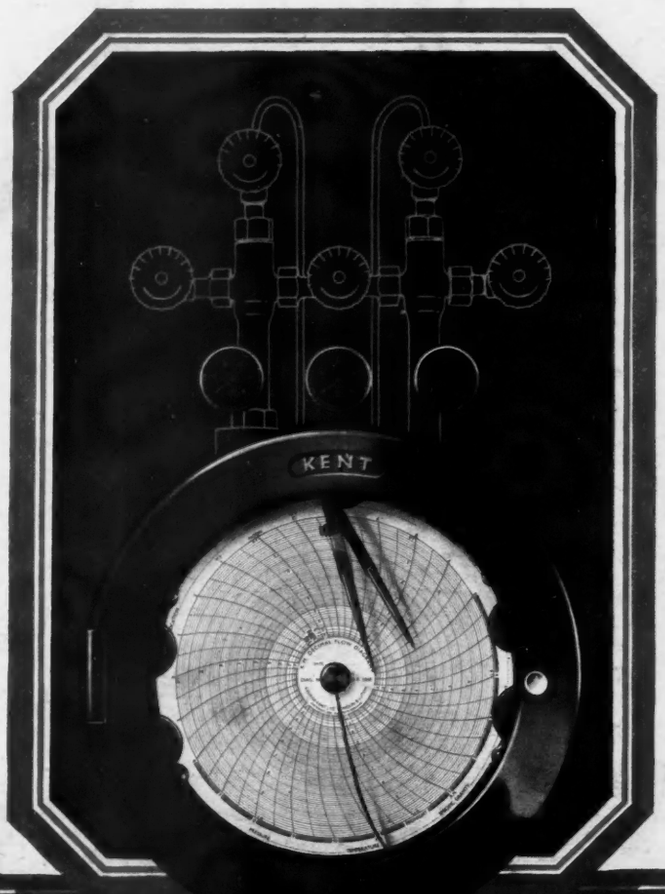

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The Engineer

LONDON, FRIDAY, OCTOBER 3, 1941

PUBLIC NOTICES

CITY OF BIRMINGHAM ELECTRIC SUPPLY DEPARTMENT

COMPRESSED AIR PIPEWORK, ETC.

The Electric Supply Committee invites TENDERS for the SUPPLY, DELIVERY, ERECTION, TESTING and PUTTING to WORK of COMPRESSED AIR PIPE WORK with VALVES, FITTINGS, &c., at Hams Hall "B" Power Station, Lea Marston, Warwickshire.

The general conditions of contract (which include the Corporation's usual Fair Wages and Conditions of Labour Clause), specification and drawings may be obtained upon application to the undersigned, accompanied by a deposit of £2, which will be returned on receipt, by the appointed time, of a bona-fide Tender not subsequently withdrawn. Cheques must be made payable to "The City of Birmingham Electric Supply Department."

Sealed Tenders, enclosed in the official envelope provided and endorsed for the purpose, must be delivered to the undersigned not later than Twelve Noon on Friday, the 7th November, 1941, when they will be opened. Tenders not complying with the foregoing will be rejected.

The Committee does not bind itself to accept the lowest or any Tender.

F. FORREST,
Chief Engineer and Manager.

14, Dale End,
Birmingham, 4,
3rd October, 1941. 7825

MUNICIPAL CORPORATION OF RANGOON, BURMA

APPOINTMENT OF ADDITIONAL OFFICER, FIRE BRIGADE

Applications are Invited for the POST of an ADDITIONAL OFFICER, Fire Brigade, Rangoon Corporation.

AGE AND NATIONALITY.—Candidates should state their age and nationality. Men between the years of 35 and 40 will be preferred, but this age limit may be relaxed in respect of candidates who are exceptionally qualified.

QUALIFICATIONS.—Preference will be given to candidates who are qualified and trained mechanical engineers and possess an intimate knowledge of electricity, petrol motor fire engines and appliances and pumping machinery. Membership of the Institute of Fire Engineers (class to be stated) and certificate from the Government A.R.P. School will be considered an added qualification.

EXPERIENCE.—Candidates should state their present and previous employment and the nature and extent of their experience in the fire brigade work. Candidates must possess a thorough knowledge of A.R.P. organisation and work. Experience in the operation of the street fire alarm system will be considered an advantage.

SALARY.—Rs. 400 (rupees four hundred only) per the first year, rising by annual increments of Rs. 20 (twenty) to Rs. 500 (rupees five hundred) per month with free quarters fitted with electric lights and fans, plus the use of a service car while on duty. Free uniform and boots will also be supplied. No other allowances or privileges are attached to the post or will be granted.

The officer appointed will be required to subscribe to the Municipal Provident Fund. Subscriptions are payable at the rate of one-twelfth of salary and an equal amount is contributed by the Municipal Corporation. Leave and leave allowances will be granted in accordance with the rules relating to the grant of leave to municipal officers and servants in the service of the Corporation. No leave passages will be paid.

Subject to the Rules governing the conditions of service under the Corporation, the appointment will be made on an agreement of contract for a period of five years, the first year of which being treated as the period of probation. If at any time during the period of probation or at the end of it the officer is found unsuitable his services may be terminated upon the Corporation giving to him three months' notice.

A free first-class passage to Rangoon from the port of embarkation will be granted and a similar return passage on the ordinary termination of the agreement provided the officer elects to return to a port in the United Kingdom within a period of six months of such termination. In case the services of the person appointed is terminated during or at the end of the period of probation and after due notice, he will be provided with a free first-class passage to the place from which he embarked for joining his appointment provided he returns within one month from the date of termination of his services.

All emoluments and other payments will be made in currency in usage in Burma and no exchange compensation will be paid.

The officer selected for the appointment will be required to pass a medical examination by a medical officer appointed by the Corporation of Rangoon or its Agents.

Applications should be addressed to the undersigned and will be received up to the 17th October, 1941.

OGILVY GILLANDERS & CO.
"Hollington,"
73, Bradbourne Park Road,
Sevenoaks, Kent.
Dated the 1st October, 1941. 7816

The Engineer

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IMPORTANT NOTICE TO ALL ADVERTISERS AND ADVERTISING AGENCIES.

Owing to further drastic limitations in the use of paper it has been decided to reduce the printed area of THE ENGINEER page as from this issue. The type space is now:—

12" in DEPTH and 9" in WIDTH, THE COLUMN WIDTH BEING 2¼".

Therefore in future all blocks and copy should be supplied to suit the new dimensions.

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

AIR CONDITIONING.—Firm of Engineers are desirous of getting in touch with a fully qualified ENGINEER, who has had experience in the Designing and Installing of up-to-date Air Conditioning Plant, with a view to coming to an arrangement for the development of Air Conditioning on scientific lines when circumstances and the times permit. Finance will be available, and the post will open up possibilities for a man of enterprise and integrity.—Address, giving full details of experience, 7797, The Engineer Office. 7797 A

SITUATIONS OPEN

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

ENGINEER, Competent Energetic Man of Good education, with sound practical and theoretical knowledge, REQUIRED as MANAGER in works making heavy machine tools. Must be familiar with modern workshop practice. State age, experience and salary required.—Address, 7817, The Engineer Office. 7817 A

PUBLIC NOTICES

MUNICIPAL CORPORATION OF RANGOON, BURMA

APPOINTMENT OF SECOND OFFICER, FIRE BRIGADE

Applications are Invited for the POST of SECOND OFFICER, Fire Brigade, Rangoon Corporation.

AGE AND NATIONALITY.—Candidates should state their age and nationality. Men between the years of 35 and 40 will be preferred, but this age limit may be relaxed in respect of candidates who are exceptionally qualified.

QUALIFICATIONS.—Preference will be given to candidates who are qualified and trained mechanical engineers and possess an intimate knowledge of electricity, petrol motor fire-engines and appliances and pumping machinery. Membership of the Institute of Fire Engineers (class to be stated) and certificate from the Government A.R.P. School will be considered an added qualification.

EXPERIENCE.—Candidates should state their present and previous employment and the nature and extent of their experience in fire brigade work. Candidates must possess a thorough knowledge of A.R.P. organisation and work. Experience in the operation of the street fire alarm system will be considered an advantage.

SALARY.—Rs. 350 (rupees three hundred and fifty only) for the first year, rising by annual increments of Rs. 15 (fifteen) to Rs. 500 (rupees five hundred) per month with free quarters fitted with electric lights and fans, plus a conveyance allowance of Rs. 75 per month. Free uniform and boots will also be supplied. No other allowances or privileges are attached to the post or will be granted.

The officer appointed will be required to subscribe to the Municipal Provident Fund. Subscriptions are payable at the rate of one-twelfth of salary and an equal amount is contributed by the Municipal Corporation. Leave and leave allowances will be granted in accordance with the rules relating to the grant of leave to municipal officers and servants in the service of the Corporation. A free first-class passage to Rangoon from the port of embarkation will be provided, but no leave passages will be paid.

Subject to the Rules governing the conditions of service under the Corporation the appointment will be permanent, subject to a probationary period of one year. If at any time during the period of probation or at the end of it the officer is found unsuitable his services may be terminated upon the Corporation giving to him one month's notice.

All emoluments and other payments will be made in the currency in usage in Burma and no exchange compensation will be paid.

The officer selected for the appointment will be required to pass a medical examination by a medical officer appointed by the Corporation of Rangoon or its Agents.

Applications should be addressed to the undersigned and will be received up to the 17th October, 1941.

OGILVY GILLANDERS & CO.
"Hollington,"
Bradbourne Park Road,
Sevenoaks, Kent,
Dated the 1st October, 1941. 7815

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CLASSIFIED ADVERTISEMENTS CLOSE
PRESS-NOON WEDNESDAYS

The Engineer

Annual Subscription Rates

(including postal charges)

Le prix de l'abonnement est accepté en livres sterling, ou dans la monnaie du pays d'origine au cours du change au moment de la commande.

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ARGENTINE ... BUENOS AIRES: Mitchell's Book Store, 576, Cangallo
BUENOS AIRES: F. W. Mole, Cangallo, 456

AUSTRALIA ... Gordon and Gotch (A'sia), Ltd., All Branches
MELBOURNE: Jervis Manton, 37, Swanston Street
MELBOURNE: Trade Press Proprietary, Ltd., 19, Queen Street

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MONTREAL: Benjamin News Company, 973, St. Antoine Street
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SHANGHAI: Kelly and Walsh, Ltd.

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BOMBAY: Popular Book Depot, Grant Road
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Gordon and Gotch (A'sia), Ltd., Wellington, Auckland, and Christchurch
NAPIER: J. Wilson Craig and Co.

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SWEDEN ... ... STOCKHOLM: A/B Wennergrens Journal-expedition, Stockholm, 1
STOCKHOLM: A/B C. E. Fritzes Kungl., Hofbokhandel Fredsgatan, 2

SWITZERLAND ZURICH: Rosa Leibowicz, 4, Ankerstr.

UNITED STATES OF AMERICA NEW YORK: International News Co., 131, Varick Street, New York, N.Y., and all Branches
Moore Cottrell Subscription Agency, North Cohocton
BOSTON: F. W. Faxon and Co., 63–69, Francis Street

Entered as second-class matter at the Post Office, New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 307, P.L. & R.).

U.S.S.R. ... ... LENINGRAD: Mesbdunarodnaja Kniga, Prospect Volodarsky, 53A
MOSCOW: Kuznetski Most 18

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4/9 each, 5/3 post free.*

*** BINDING CASES *for half-yearly volumes of* THE ENGINEER, *in cloth 5/- each, 5/3 post free.*

PAPER SUPPLIES

With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, October 31st.

ADVERTISEMENTS

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address, 28, Essex Street, Strand, London, W.C.2. Teleg. Address, "Engineer Newspaper, Estrand, London." Tel., Central 6565 (10 lines).

PUBLIC NOTICES

CITY OF CARDIFF EDUCATION COMMITTEE

THE TECHNICAL COLLEGE

Principal:
JAMES STEPHENSON, M.A., M.Com., D.Sc.

Required to Commence Duties as early as possible, a FULL-TIME LECTURER in ELECTRICAL ENGINEERING SUBJECTS to Honours Degree and Higher National Certificate standards. Ability to take subsidiary Mechanical Engineering subjects will be a recommendation.

The salary will be in accordance with the Burnham Technical Scale, provision being made for previous industrial and teaching experience.

Forms of application, together with further particulars, are obtainable from the undersigned, to whom they should be returned, accompanied by a letter of application in the candidate's own handwriting, by 8th October, 1941.

W. J. WILLIAMS,
Director of Education.

City Hall,
Cardiff. 7790

SITUATIONS OPEN

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDER

ASSISTANT CHIEF METALLURGIST REQUIRED. Applicants should have wide Metallurgical experience rather than specialised knowledge of any one branch. Practical experience in Metallography, Mechanical Testing, and Chemical Analysis is necessary. A knowledge of Production Heat Treatment and Electroplating in connection with Aircraft Materials, Ferrous and Non-ferrous, will be an advantage.—Address, 7813, The Engineer Office. 7813 A

CONSULTING ENGINEER.—Established Firm of Contractors REQUIRE FACILITIES for OCCASIONAL CONSULTATION with an Engineer or Firm of Consulting Engineers, competent to Design Steel Masts and Towers of any height.—Address, 7827, The Engineer Office. 7827 A

MAINTENANCE MANAGER.—A North-West Firm wish to APPOINT MANAGER for their extensive Maintenance Department dealing with thousands of customers' machines. Applicant must have knowledge of Engineering and extensive Experience in Handling of Large Works or Maintenance Department. Exceptional progress can be made by keen and efficient man.—Write, giving age, salary, and full details of previous experience, and photograph if possible, to 7821, The Engineer Office. 7821 A

PROMINENT CONTRACTORS REQUIRE capable AGENT to Take Charge of Reconstruction Work in North-West area. Must be used control of men. Excellent prospects.—Address, 7696, The Engineer Office. 7696 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WELL-KNOWN Midlands ELECTRIC FURNACE MANUFACTURERS have a VACANCY for a TECHNICAL SALES REPRESENTATIVE. The position has excellent prospects and only first-class men need apply. Applications will be treated confidentially and should give full details of experience, age and indication of salary expected.—Address, 7826, The Engineer Office. 7826 A

DRAUGHTSMAN (about 25) for Maintenance of Clinker Processing Plant; £7 p.w. to commence, rising £25 p.a. to £520.—Address, 7828, The Engineer Office. 7828 A

SITUATIONS WANTED

A CONSULTING ENGINEER is Just Completing the Introduction of Centralised Production Control for the whole of an important section of the Steel Foundry Industry and will be AVAILABLE SHORTLY. Wide technical experience in petroleum, chemical, and light engineering industries.—Write, "H.R.," c/o Streets, 6, Gracechurch Street, London, E.C.3. 7809 B

ARTICLED ENGINEER, Over Military Age, is anxious to REPRESENT COMPANY in London; well acquainted with Government and Export Business.—Address, P3558, The Engineer Office. P3558 B

ASSISTANT WORKS MANAGER and TECHNICAL MANAGER to General Engineers employing 450 DESIRES suitable responsible POST with firm of Mechanical Engineers. Present post becoming a sinecure due to large running Government contracts. Age 34. First-class education and training. Thorough experience of Ironfounding, Steam Hammer Forge, Heavy, Light and Production Machining and Fitting, Metallurgy, Heat Treatment, A.I.D. Inspection, Factory Lay-out, Estimating, Factory Costs, Production and Labour Control. Salary required £750 to commence.—Address, P3551, The Engineer Office. P3551 B

SITUATIONS WANTED

B.Sc. (Lond.), B.Sc. (Eng.), A.M.S.E., M. Inst. Met., age 25, lab., works and D.O. experience present employment, tool designer, SEEKS OPPORTUNITY in DESIGN requiring extensive chemical knowledge, preferably abroad.—Address, P3550, The Engineer Office. P3550 B

ENGINEER (27), at Present with Maintenance dept. large Midland company, DESIRES CHANGE; fully experienced structural engineering, inside or outside, plant lay-out, building design, &c.; used labour control; home or abroad; anything considered.—Address, P3557, The Engineer Office. P3557 B

ENGINEER (41), Electrical, Mech., Building, plant, D.O., tech. and administrative, works, contract, sales, &c., and wide gen. eng. experience, qualified, SEEKS POSITION. Free now. London or H.C.—Address, P3553, The Engineer Office. P3553 B

IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

MECH. ENGINEER, Age 28, with Good education, engineering degree, full apprenticeship, six years' sales and tech. experience and some electrical knowledge, REQUIRES PERMANENT POSITION with prospects.—Address, P3538, The Engineer Office. P3538 B

PRODUCTION CONTROL MANAGER of varied experience, excellent organising abilities applicable to any conditions, DESIRES APPOINTMENT in London area.—Address, P3548, The Engineer Office. P3548 B

AGENCIES

TECHNICAL REPRESENTATION. — FIRMS engaged in Supply of Material and Plant for urgent contracts in the Clyde area COULD SAVE MUCH TIME by UTILISING our LOCAL OFFICE FACILITIES and TECHNICAL SERVICES which would be at their disposal for the duration.—Address, P3547, The Engineer Office. P3547 D

EDUCATIONAL

ENGINEERING.—SPECIALISED TRAINING in MECHANICAL and STRUCTURAL ENGINEERING by PRACTISING ENGINEER with 20 years' experience. Training adapted to individual requirements. Moderate deferred terms.—Address, P3554, The Engineer Office. P3554 E

AUTHORITATIVE CORRESPONDENCE TRAINING

25 FIRST PLACES
and HUNDREDS OF PASSES in the A.M. Inst. C.E., A.M.I. Mech. E., A.M.I. E.E., A.F.R.Ae.S., A.M.I. Chem. E., C. & G., etc. Examinations have been gained by T.I.G.B. Students.

Especially in view of Air Raid and Working Conditions, study at home with the T.I.G.B. in order to achieve the best progress and results. Write to-day for "The Engineer's Guide to Success"—FREE—containing the world's choice of Engineering Courses—over 200—covering all branches and recognised qualifications. Mention branch, post of qualifications that interests you. The T.I.G.B. guarantees training until successful.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
76, TEMPLE BAR HOUSE, LONDON, E.C.4.

MISCELLANEOUS

FIRM OF LONDON CATERERS, Well supplied with small equipment, WISH to UNDERTAKE CATERING for large works canteen.—MONNICK, Ltd., 94, Burnt Oak Broadway, Edgware, Middlesex. P3545 I

INVENTORS.—A Well-known and Responsible ENGINEERING COMPANY SEEK NEW INVENTIONS and PRODUCTS in all branches of industry for development and production.—Communicate in first instance with Messrs. ERNEST W. HADEN & STRETTON, Solicitors, Bridge Street, Walsall, Staffs. P3429 I

SMALL ENGINEERING COMPANY, Seeking a new product to replace own for which demand is diminishing, OFFERS FINANCIAL and PRECISION MANUFACTURING FACILITIES to inventor, or would reward any person introducing or suggesting a suitable line with good prospects of development. Small self-contained units preferred, but not essential.—Address, P3549, The Engineer Office. P3549 I

PATENTS

THE PROPRIETORS of the PATENT No. 343,066, for "Improvements in or relating to Fittings for Reinforced Tubing," are DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to Haseltine Lake and Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. 7818 H

MACHINERY, &c., WANTED

WANTED, 7-ROLL PLATE-STRAIGHTENING MACHINE, blades 4ft. wide by 1 thick, hot. Particulars.—Address, 7833, Engineer Office. 7833

WANTED, SHEARING MACHINE with blades, cap. about 20in. or more, to up to about 1¼in. or 2in. plate, but also centre cropping blades. Particulars.—Address 7832, The Engineer Office. 7832

WANTED, WATER-TUBE BOILERS, Babcock or Stirling only, up to 50,000 lb. evaporation, 200 lb. working pressure or higher. Address, 7384, The Engineer Office. 7384

WANTED, HEAVY SET of SCRAP SHEARS capable of cutting up to 12in. by 6in. rolled steel joists.

Also SCRAP SHEARS with blade about 26in. 30in. gap, for 1¼in. plate, 1¾in. rounds.

Also GUILLOTINE SHEARS, capable of dealing with up to 1in. plate.

The above machines are urgently wanted for work of national importance.
Address, 7806, The Engineer Office. 7806

ALFRED HERBERT, Ltd., Coventry, PAY BEST PRICES for SECOND-HAND MACHINE TOOLS in good condition by first-class makers.

Write, wire or 'phone, and our representative will call.

'Phone: 88781 (12 lines) Coventry; Telegrams: "Lathe, Coventry." 1002

BLUE-PRINT MACHINE WANTED for Engineers' Office; new or S/H. Please send full details.—Address, P3546, The Engineer Office. P3546

SURPLUS PLANT & MACHINERY REQUIRED TO SATISFY URGENT ENQUIRIES, ESPECIALLY:

Boilers, A.C. Motors, D.C. Motors, Diesel Engines, Diesel-driven Generating Sets, Steam Engines, Steam-driven Generating Sets, Colliery Plant, Air Compressors, Turbo and other Pumps, Rubber Plant, Plastic Moulding Plant, Hydraulic Presses, Hydraulic Pumps and Accumulators, Crushers, Cranes, Locomotives, Tanks, Piping, Rails and Wagons, Joists and Steel Buildings, Chemical Plant. Needed for work of urgent national importance. GEORGE COHEN, SONS & CO., LTD., Wood Lane, London, W.12, and Stanningley, nr. Leeds.

PLEASE OFFER US YOUR SURPLUS MACHINES

As Licensed Dealers in MACHINE TOOLS we have numerous inquiries on our books for all types of machines for work of vital national importance. Our representatives will inspect and make spot cash offers for MACHINE TOOLS and SHEET METAL WORKING MACHINERY of every description.

F. J. EDWARDS LTD.,
359, EUSTON ROAD, LONDON, N.W.1
Telephone No.: EUSton 4681
Telegrams: "Bescotools, Norwest, London."

ELECTRIC GENERATOR WANTED to develop about 150 kW for 400/440 volt three-phase, 50 cycles. Complete with Starting Equipment if possible. State make, age, and full particulars.—Address, 7823, The Engineer Office. 7823

GEORGE COHEN, SONS and CO., Ltd., Wood Lane, London, W.12, REQUIRE to buy inquiries from firms on work of national importance, first-class SECOND-HAND ELECTRIC MOTORS and GENERATORS of all sizes, 220 volts D.C. or 400/440 volts, three-phase 50 cycles; also modern SWITCHGEAR, &c. 7824

SUB-CONTRACTING

WANTED

DRAWING-OFFICE NOW HAS CAPACITY for ADDITIONAL DESIGNING, DETAILING and TRACING. Specialising in power plant, factory lay-out, and mechanical detail. Address, P3555, The Engineer Office. P3555 MW

FOR SALE

CHEAP REINFORCING BARS FOR SALE, large tonnage, various diameters and lengths. ISTEG BARS also available. State requirements.—Address, 7772, The Engineer Office. 7772

CRANES FOR HIRE.—TWO 2-Ton "Butters" All-steel HAND DERRICK CRANES, with 40ft. jibs; new last year to B.S.S. TWO 30-Cwt. capacity "Morris" HAND-OPERATED TRAVELLING CRANES, with road and 4ft. 8½in. gauge rail wheels. ONE 9-Ton "Morris" HAND-OPERATED TRAVELLING GOLIATH TYPE GANTRY, 21ft. 9in. span, 18ft. high.—HAROLD POTTER and CO., LTD., Canal Street, Nottingham (Tel., 44620). 7819

For continuation of Small Advertisements see page 64

Vertical Milling Machine all geared, hardened and ground throughout, ball and roller bearings, swivelling head, 30"x8" Table. HENRY MILNES LIMITED, Machine Tool Works, Ingleby Street, BRADFORD

A Seven-Day Journal

Canadian War Transport

ON Saturday, September 27th, the Ministry of War Transport announced the resignation of Sir Edward Beatty, G.B.E., as the Canadian representative of the Ministry and of Mr. George Stephen, the assistant representative. In accepting these resignations Lord Leathers has expressed to Sir Edward Beatty and Mr. Stephen his great appreciation of and thanks for the valuable and arduous services which they have rendered since the outbreak of war. The Government is indebted to them for the creation and development of the organisation upon which the British Ministry of Shipping and later the British Ministry of War Transport so largely depended for the execution of its purposes in Canada. The Ministry has gladly accepted Sir Edward Beatty's generous offer that the services and co-operation of the Canadian Pacific should continue to be at the disposal of the Ministry. The extraordinary growth of the Ministry's activities in the past year and the vast expansion of shipping planned for the future have made desirable the creation of a Board of Directors which Sir Edward Beatty and the Minister jointly agree should be composed of men able to devote their entire time and energy to war transport problems. After consulting the Canadian Government, the Minister has appointed Mr. G. D. Huband to succeed Sir Edward Beatty as his representative in Canada as from October 1st, 1941. Mr. Huband will have the assistance of a board consisting of the four existing directors who are members of the Canadian Pacific organisation and of other members who will be appointed from among prominent representatives of the shipping community. Mr. Huband, who has since the beginning of the war been assisting Sir Ashley Sparks, the Ministry of War Transport representative in America, was immediately prior to the war representative of the Cunard White Star, Ltd., in Montreal. The offices of the Canadian representative will be maintained at the Windsor Station of the Canadian Pacific in Montreal.

Retirement of Mr. Robert J. Norton

AFTER twenty-five years' service, Mr. Robert J. Norton, a director of Petters, Ltd., of Yeovil and Loughborough, has, for health reasons, been compelled to retire from active duty with the company, of which, however, he remains a director. In addition to his long association with the oil engine business of the company, he was intimately connected from its inception, with the development of Westland Aircraft, Ltd., which formed a branch of the company's activities for many years. Mr. Norton's exceptional business ability and philosophical outlook made him a very large number of friends, and high tributes were paid to him recently by Mr. Alan P. Good, deputy chairman of the Brush Electrical Engineering Company, Ltd., with which Petters, Ltd., is associated; and Captain R. C. Petter, director and a colleague of Mr. Norton, when presentations were made on behalf of the directors and staff. Mr. Norton still remains a director of Associated British Engineering, Ltd., and Rubery Owen Messier, Ltd.

A Record Output of Tanks and Armoured Vehicles

THE reports of the Ministry of Supply for the week's effort for the production of "Tanks for Russia," in order to implement Lord Beaverbrook's promise to give the utmost aid to our Ally, show that all sections of the industry gave to the effort their best support. Apart from the special week for Russia, during which the increase of tank production compared with previous records was increased by over 10 per cent. and nearly 20 per cent., it is now stated that during the months of July, August, and September more tanks were completed than during the whole of last year. It is also learned from the Ministry's reports that last week's drive was an all-time record, for the manufacture of all kinds of armoured fighting vehicles used by the British Army. More armoured carriers were made than ever before, and more scout cars were turned out by the vehicle plants than in any previous week. The production of armoured cars was, the Ministry states, easily a record, and it equalled the total output for the whole of the previous month. Not only were new records achieved in foundries, plate-rolling mills, and steel works, but similar record outputs were obtained in hundreds of small plants making the necessary component parts and at the tank erection centres. In individual factories holidays were indefinitely postponed, and a full 6½-day week was worked, with a great measure of overtime. The Ministry of Supply has planned a rapidly expanding tank production programme, which is based on a long-term policy for the constant flow not only of those special types of tank selected in order to meet the immediate needs of the Soviet Forces, but also to maintain simultaneously the increasing requirements of our own swiftly expanding armoured fighting forces.

British Shipping Losses

IN the course of his speech made in the House of Commons on Tuesday, September 30th, the Prime Minister, Mr. Winston Churchill, reviewing the progress of the war, stated that the losses from enemy action of British, Allied, and neutral merchant ships during the quarter July, August, and September, had been only one-third of those losses during the quarter April, May, and June. During the same period, Mr. Churchill went on to say, our slaughter of enemy shipping, German and Italian, had been increasing by leaps and bounds; in fact, it was about one and a half times what it was in the previous three months. At one end we had a reduction in average monthly losses of about a third, and simultaneously an increase of the losses inflicted upon the enemy of half as much again. These important results enabled us, he said, to take a more expansive view of our import programme. Very few important ships carrying munitions had been lost on the way. Our reserves of food stood higher than they did at the outbreak of war, and far higher than they did a year or eighteen months ago. We were now within measurable distance of the immense flow of American new building, to which, together with our own construction, we looked to carry us through 1942, and on progressively till the end of the war. We must expect that the enemy U-boat warfare, now conducted by larger numbers of U-boats than ever before, supported by scores of Focke-Wulfs, would be intensified. That effort of the enemy would, Mr. Churchill said, be beaten, and kept beaten only by a corresponding intensification of our own measures and by the assistance that we were receiving in an increasing degree from other quarters. We could not afford to relax for an instant.

London Transport's Winter Plans

ON Wednesday, October 1st, particulars were issued of the winter travel plans which come into force on the systems of the London Passenger Transport Board during the month. They will be introduced on the Underground Railway system on Monday, October 6th, and on the 8th for the Green Line coaches and country buses. In the case of the central buses, the trams, and trolleybuses, the plans will come into operation on Wednesday, October 29th. Workers at war factories, which have greatly increased in size since last winter, have received first consideration in drawing up the new schedules, and in factory areas many improvements and additions to the tram, bus, and trolleybus services have been made. A substantial gain has been made by the adoption of the system of staggering of working hours, already referred to in these columns. More than 400,000 workers will benefit by the readjustment by 15-min. intervals of the times of beginning and ending work. All forms of transport will continue to run at full strength until about 9.30 a.m. to carry the morning rush hour traffic. To meet the demands of the evening rush hour, services will be built up from about 3.30 p.m. so that maximum services are working by 4 p.m. The peak services will be maintained as long as is necessary, but the number of vehicles will be scaled down until black-out running begins about 7 p.m. It is expected that even with the adoption of staggered hours, there may still be some queueing up in Central London. More portable shelters are being constructed to protect waiting passengers. The necessity of saving petrol and fuel oil and the increased provision of transport for the war factories will make unavoidable some reduction in bus services between 10 a.m. and 3.30 p.m. From October 1st passengers holding the return halves of cheap day railway tickets will not be permitted to travel from London on week-days, excluding Saturday, between the hours of 4.30 and 6.30 p.m. It is announced that there will necessarily be some curtailment of the omnibus services after the evening peak period, but in order to compensate for the reduction of road services in the black-out and to provide transport between the main line terminal stations, services on the Underground Railways will be more frequent than last year. Central buses, trams, and trolleybuses will begin their last journeys from the Central London area about 10.30 p.m. Last trains on the Underground will run at the customary times, leaving stations in Central London about half past midnight.

The Late Sir Herbert Holt

ON Sunday, September 28th, the death took place in Montreal, at the age of eighty-five, of Sir Herbert Holt, who for some years past has wielded a dominating influence in the industrial and financial life of the Dominion of Canada. Sir Herbert came of Irish stock and was born in County Kildare in 1856. He was educated in Dublin and studied civil engineering. Before he was twenty he went out to Canada and at the age of twenty-five he was entrusted with the supervision of the construction of the Credit Valley line, which was then being built. For some time he was engaged on railway construction with the Canadian Pacific Railway Company in Western Canada, but he relinquished that work to start a business in railway contracting on his own account. He was successful in his many operations and during the next ten years he was a busy railway builder, not only in Canada, but also in the United States. By the age of forty he had amassed a fortune, and he settled in Montreal. Abandoning railway construction, he co-operated with the late Mr. C. R. Hosmer to acquire control of public utility undertakings supplying gas, electricity and other services in the city and district of Montreal. Having taken over the Montreal Gas Company and the Royal Electric Company, Sir Herbert merged these two companies with other undertakings in the surrounding district and formed the Montreal Light, Heat and Power Company, of which he was president for over forty years. In his later years he became interested in banking and became a director and later the president of the Royal Bank of Canada. His wide knowledge of industrial undertakings was of great value to the bank and he adopted a progressive policy which developed foreign business, particularly that with the West Indies.

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A "Beyer-Garratt" Locomotive Experience

By EDWARD H. LIVESAY

L.M.S.R., London-Toton

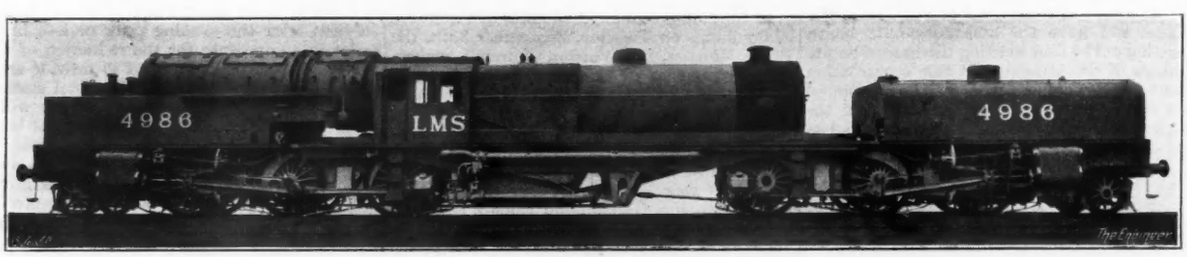
I HAVE travelled on many interesting locomotives recently, as the pages of The Engineer have testified, but the articulated type has only once come within my orbit—unless booster-equipped engines are regarded as being such, as logically I suppose they can be. Disregarding these, however, there are no articulated engines in Canada, and the "Mallets" in the United States have so far been out of my reach; I hope to rectify this some day. When visiting England I put the "Garratts"* on the list of locomotives whose work was worth studying, and so I am indebted to the L.M.S.R. for the opportunity to extend my footplate experiences to the engines of this type employed on the heavy coal traffic between Toton and Brent, London. I wished to confirm or disprove certain theories I had held about the "Garratt," in which I have always been very interested ever since its inception, and the runs dealt with in this article made it possible for me to do so. It should be explained, however, that they took place last year, soon after the breaking up of the long and severe winter which so upset rail traffic in many parts of the country, and seriously depleted London's coal supplies. The resulting unprecedented heavy demand for coal taxed the railways acutely; almost a procession of coal trains was noted rolling southward during these runs, and sidings and marshalling yards were very congested, so it is not to be wondered at that normal schedules were upset, and that the times and delays recorded in this article bear no relation to the usual working conditions. Further, the Atlantic now separates me from reference books and informed authorities to whom I might appeal in case of need, so if any slight errors have crept in this should be remembered.

The "Garratt" locomotive dates from 1909, when the first example was built. The chief idea governing the design was that the engine should be suitable for service over light permanent way where curvature was rife; that it should have ample boiler power and plenty of adhesive weight without overloading individual axles. There were, of course, many other associated advantages; the separate boiler unit enables the generator to be of large diameter, as it is free from restrictions imposed upon it by the proximity of driving or carrying wheels. The same latitude extends to the fire-box, which can be wide and deep and of large volume, without adding a combustion chamber, at best an expensive annexe. The length of the boiler can be kept within limits that are decided solely by the capacity desired and is not affected by the need to find room for the wheels beneath it, as is sometimes the case with non-articulated engines, and "Mallets." A boiler of moderate length and large diameter ensures that most of the heating surface is effective, whereas one with over-lengthy tubes means that a considerable proportion of the heating surface may be of doubtful value. Other incidental advantages of the "Garratt" system can be cited; great stress may be laid on the simplicity and efficiency of the boiler, which, after all, is the heart of a locomotive. Was not Ivatt responsible for the aphorism "the measure of a locomotive's capacity lies in its ability to boil water," or words to that effect? The maxim is as true as ever, and the straightforward "Garratt" boiler excels in this respect. Weight distribution is good, a large proportion being available for adhesion without individual axles being heavily loaded, and flexibility is naturally far beyond anything that can be attained by the non-articulated type of engine. A characteristic feature of the "Garratt" is that when a curve is entered the boiler unit moves over transversely to the inside, thus increasing stability at speed. That the "Garratt" is well adapted to high-speed running has been proved beyond a peradventure, the 4–6–2 + 2–6–4s running in Algeria, for instance, having attained over 80 m.p.h., and this with wheels only 5ft. 11in. in diameter. There is little doubt that a suitably designed "Garratt" engine could equal the highest speeds reached by the non-articulated locomotive, possibly with greater safety, and with reduced track and engine stresses.

The development of the "Garratt" locomotive has been continuous and rapid. From a small eight-wheeled compound type weighing less than 34 tons, built in 1908 for service in Tasmania, on a 2ft. gauge, it has developed into a machine running on sixteen axles, approaching 250 tons in weight. Its growth has been very striking, but it should be remembered that the particular engines dealt with in this article are far from being typical of the latest "Garratt" practice, which has made such particularly rapid strides during the last decade. For reasons quite apart from the design itself, this type of locomotive has not come into very considerable use in Great Britain, the L.M.S.R. employing most of those to be found in the country, in number thirty-three. These engines are dealing with the heavy coal traffic between Toton (Nottingham) and London.† Their chief dimensions are as follows:—

Cylinders (four)	18½in. by 26in.
Coupled wheels	5ft. 3in.
Wheel base:	
Each unit	25ft. 9in.
Rigid	16ft. 6in.
Total	79ft.
Heating surface:	
Tubes	1954 square feet
Fire-box	183 square feet
Superheater	500 square feet
Total	2637 square feet
Grate area	44·5 square feet
Boiler pressure	190 lb.
Tractive effort at 85 per cent.	45,620 lb.
Adhesive weight	119·5 tons
Total weight	152·5 tons
Factor of adhesion	5·9
Coal capacity (revolving bunker)	9 tons
Water capacity (pick-up apparatus)	4500 gallons

The revolving coal bunker is a very useful labour-saving accessory, trimming the coal forward, reducing the fireman's work, and freeing him at times for other duties. As will be seen, it is a conical container, with its axis inclined towards the front. It is revolved by two small reversible engines driving through worm gearing, and makes a complete turn in about thirty seconds, three or four revolutions being enough to bring the coal from the rear to the front of the bunker. The total enclosure of the coal prevents dust blowing about and inconveniencing the crew when the engine is running bunker first, an important point with an engine such as the "Garratt," which ignores turntables. The cab is all-enclosed for the same reason.



L.M.S. Beyer-Garratt Locomotive

Before dealing with the running of these engines it is advisable to emphasise again that the design is fourteen years old, and is now far from typical of "Garratt" practice, which has advanced very greatly since these particular engines came out. Further, they are really neither solely a Beyer, Peacock nor an L.M.S.R. design, but hybrids, and, like most hybrids, suffer accordingly. There is, however, one great advantage in this: when defects show up, each of the partners in the production can blame the other! I am not, of course, suggesting that there *are* defects or that the companies actually do this—the idea has merely occurred to me; it is what I should do if I were concerned, I know. It is possible to criticise some points in this particular design, but far more difficult to do so when modern "Garratts" are up for review. The principles of old and new "Garratts" remain unchanged, but the details have been almost revolutionised in the light of experience gained in varied service all over the world—with the exception of North America.

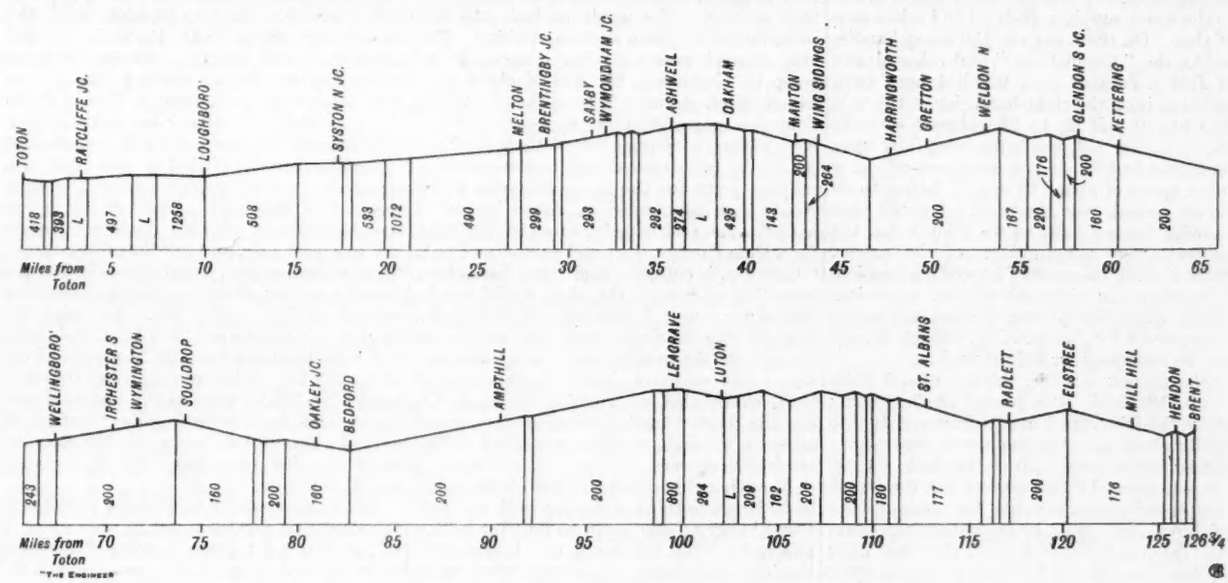
The distance between Toton and Brent is 127 miles. The coal trains handled by these "Garratts" are made up of about ninety wagons—loaded—coming to London and empties being returned. Before these engines

* The name adopted by the firm is "Beyer-Garratt," but we retain Mr. Livesay's "Garratt" as descriptive of a type.—Ed., The E.

† The photograph shows the number when the engines were built. They are all now in the seven thousands.—Ed., The E.

were available, two of the ordinary six-coupled goods type were employed, but double heading is now a thing of the past, and the former uneconomical practice has been eliminated. The first run to be described was from Brent, with a train of ninety empty wagons—say, 700 tons—and the engine was "No. 7995," with Driver Reeves and Fireman Pinder. It left at 10.45 a.m. in showery weather, the first thing noted being how well the ample adhesive weight and four cylinders lent themselves to the very careful get-away demanded by the slack-coupled, lengthy train. The start was made on a gently falling gradient, with the regulator only just open and 65 per cent. cut-off; the steam was a little down, 175 lb., but it soon rose, and in a few minutes was blowing off. Before we were clear of suburbia the weather cleared up, giving dry rails; approaching Hendon there is a short incline of 1 in 191 up, which called for a cut-off of 25 per cent.; once over the crest, on a falling gradient of 1 in 374, an adverse signal brought the train to a stand. The restart was made very gently, the regulator passing only a whiff of steam, to be 15 per cent. cut-off; pretty good with 700 tons, as the gradient is 1 in 177. The weather was now sunny and warm, but the cab, though enclosed, was quite comfortable, owing to the generous roof ventilators. Over the see-saw stretch to Leagrave the speed remained in the 30s, and I noted various little points, such as brake control methods. There is a steam brake on the engine, with additional hand gear, the wheel of the latter being in front of the fireman's seat. On the guard's van there is a hand brake, and I was surprised to notice how quickly the retarding effect of this 20-ton vehicle was felt throughout the entire train, and the result it had on the engine itself, in the form of a snatch that could also be felt. It induced another response, too, instantaneous and *apropos*—the crew's comments, which I much regret it seems inadvisable to quote. What a pity it is that there seems no possibility of continuous brakes being adopted on British freight rolling stock as a universal fitting. Think of the speeding-up of traffic that would result—the increased capacity of each given route—and of the cars that could be used. keep in beat as the separate engines of the 'Garratts' do. It is by no means easy to suggest a reason why they should do so.") Quoting this has induced cogitation. The only factor that affects both sets of cylinders is the blast pipe, common to all four. Can this be the cause—the increased back pressure when two cylinders exhaust together tending to bring them into step, and keeping them so? The mystery could then be solved by providing separate blast pipes and double chimneys. Theoretically, of course, it is not an advantage that the engines keep in step; it would be better if they did not, both as regards blast and torque.

It will be seen from the profile, which only gives averages and ignores minor fluctuations, that a long descent begins near Leagrave, extending almost uninterruptedly to Bedford. Fireman Pinder took things more easily here; he had been busy enough up to this point, the 45 square foot grate and four cylinders giving him little respite. He took the opportunity to revolve the bunker, a considerable labour saver. Without it, I should imagine the average fireman would



PROFILE OF L.M.S. LINE TOTON TO BRENT

opened up on the succeeding long and quite severe 5 miles climb to Elstree, where 35 per cent. valve travel was necessary. The soot blower was turned on here; open country and an up gradient form the best venue for the use of this accessory; the vicinity of a station is not well chosen. The engine was running bunker first, so the passage through Elstree tunnel was made in comfort, and with clear vision. Down the 1 in 200 drop to Radlett the speed rose to 35 m.p.h., and I noticed a certain rhythmic nosing of the outer ends of the engine units, synchronising with the throw of the connecting-rods; slight, but obvious. The engine was steaming well, however; there was considerable blowing off, difficult to check when the regulator was shut save by putting on an injector. There were, as usual, two of these, exhaust and live steam, the former being chiefly relied upon. These engines evidently use a good deal of water; an injector was generally on, and because of this I gathered it was apt to be difficult to raise the steam pressure if for any reason it had dropped. The boiler is not over-generous in its dimensions in association with four 18½in. cylinders.

On the rise to St. Albans the speed was about 15 m.p.h., with one-third regulator and But I suppose it must remain a dream. I am British (thank God!), and I hate finding fault with anything British, all the more so under present circumstances, but I must admit that watching a train of clanking, loose-coupled 10-ton trucks trundling through the countryside induces mixed feelings. I love it because it is British, but I hate it because it is out of date! However, I digress.

The riding of the engine was very good, as I had expected. Track reactions were almost non-existent, any motion in the cab being due to the engine itself. I noticed, too, that the exhaust sounded as though the two units tended to keep together, in step, instead of being "all over the place," which one would think most likely. For some reason I cannot explain, the two pairs of cylinders persistently exhausted together—there seemed to be only two cylinders in operation. (With reference to this, the Editor writes: "This is one point that interested me very greatly, as I had observed it myself on one occasion many years ago, when Dugald Drummond produced his engine—'No. 720,' L.S.W.R., E. H. L.—with two pairs of cylinders driving separate axles without coupling rods. He took me for a run on the footplate, and it was noticeable that the engines seemed to get peevish—with justification. It was turned about three revolutions: a couple forward, and one back, and did its job so well that, on the door being opened, it enthusiastically trimmed a quarter of a ton of coal out on to the floor. Flitwick, 35 miles from Brent, was passed in roughly 75 min. I shall not bother much about times on these runs, as the speed never exceeded 35 m.p.h., and the schedule was affected by signal checks. The constant slight nosing was always in evidence; it was not felt on the engine unit, but could be seen. I noticed along here the strenuous work being done to satisfy London's insatiable maw with coal. Train after train of loaded wagons passed, moving south; the next day I should be joining the procession. It was the aftermath to the severe winter, with its snow blockade.

At Bedford a 13-min. stop was made for water. These engines have pickup apparatus, which is used whenever possible, but sometimes the speed over the troughs is too low to make it worth while, and on both these runs extra stops were made at water columns. There is a tall water gauge behind the fireman's seat, showing the total tank content of the two units. No surging takes place in it, such as is seen in a boiler gauge, though

it is not always easy to see at a glance just what the level is—for this reason, it now occurs to me.

Bedford is on an up gradient, and so the slack couplings called for a very careful get-away, made with one-third regulator and 25 per cent. cut-off. What a boon centre couplings and air brakes would be if only it were possible to adopt them. Average speed would be greatly increased, and therefore the capacity of the track, too. But I have said this before. So we left Bedford, over a maze of crossings and points, where the riding was very good indeed; they were quite imperceptible. Watching this and that on "No. 7995," a novel type of engine was making my trip very interesting, and for a while I even forgot the war which, though at this time still in its "phoney" stage, had nevertheless affected the run in certain ways. It intruded every now and then; what were those things over there, with their steel-helmeted guardians? Guns, ready and waiting for eventualities. Good luck to them, we said.

Oakley was passed at 1.50 p.m., without calling upon the troughs for a contribution to the water supply; Bedford had taken care of that. On these engines the scoop handle, unlike the "Coronations" and other classes of L.M.S. engines with which I have been familiar, is on the right-hand side of the cab. The heavy pull up to Sharnbrook summit, partly at 1 in 119, was taken with fully open regulator and 18–20 per cent. cut-off, at a mean speed of about 15 m.p.h., falling to 10 as we passed over the peak. I noted that running bunker first, as we were doing, the controls were not in front of the driver. Some French "Garratts" have them doubled, convenient for either-directional operation, which theoretically would seem advisable, at any rate for fast running, though it may not be necessary for freight work.

Sharnbrook summit, the top of a 3 miles 1 in 119 climb, was passed at 2.18 p.m.; down the following 1 in 120 drop, nearly into Wellingborough, the regulator was shut; the station showed 2.30 on its clock. Again I was impressed by the perfect way the engine took crossings and switches, the entire absence of lurch and sway being almost uncanny. At Glendon Junction we left the main line; up the 1 in 167 rise to Weldon the regulator was full open, with cut-off 30 per cent. Here the train went into a siding, remaining there 15 min. before going on through the 2 miles long Corby tunnel. North of this there is a succession of sharp curves, which were taken in a way only possible to an articulated engine. It snaked its way round them with a sinuous ease that made it difficult to tell when one was on a curve at all, except when the engine was felt to cant to the inside. There was never an entering lurch or any sign of objection on the engine's part, no matter how sharp the curvature. I was still enjoying this perfect action when we ran out on to the great Welland viaduct, and thence up, at 1 in 167, through Glaston tunnel, during the passage of which the speed came down to 10 m.p.h. At Manton there was another stop for water; then a 4 miles pull up to Oakham, and again an entry to and stop in a siding, through a very sharp bend, where the engine's perfect action was again apparent, over and through switches. We remained stationary 25 min., the restart being made at 5.20 p.m. The working time-table was no longer of any interest; we should by rights have been nearing Toton, but were still many miles distant from that haven where we would be.

From Oakham it is mostly level and down-hill to Melton Junction, 12 miles on, and the fireman could relax. He had had no snap so far, though the sloping grate made his task somewhat easier than it would otherwise have been by allowing most of the fuel to be placed at the rear and round into the corners, than to shake down to the front. Without the revolving bunker his job would have been far harder, as a 45 square foot grate associated with four 18½in. cylinders would make steam-keeping a labour of Hercules if the engine were really extended for any length of time. A mechanical stoker would be essential, in my opinion, to bring out the engine's full potentialities.

Whissendine still showed a few patches of snow beside the track, on this March 10th, mute evidence of the abnormal conditions that had disrupted England's fuel supplies earlier in the year (1940, of course), and which were responsible for the procession of coal trains that were pouring past us towards clamorous London. Melton troughs were ignored; our speed was too low to make pick-up possible, and a stop was made at Melton Mowbray for water; these are thirsty machines, evidently.

Running through Brooksby and the adjacent hamlets, it was difficult to realise we were at war; the whole outlook was the embodiment of peace and tranquillity. The idea seemed unreal—it was impossible to grasp it. Here was the Old England as I had so often pictured it from far-off British Columbia, peaceful, stable, at heart unchanging; villages clustering round their spiritual centre, a greystone church; the tower a rallying point for the hedge-bordered farmsteads that surrounded it. It all looked so happy, sane, and homely, so satisfying, that for a time I forgot wars and rumours of war, "Garratts," cut-offs, and such-like alien, intruding matters. But they would not be denied for long. Loughborough, 7.25 p.m., brought the black-out into the scheme of things. At the troughs water was picked up, and a fast, close-coupled, air-braked freight train overhauled us, running at 45 m.p.h. on the other track, pointing the moral inherent in chain-coupled, unbraked rolling stock such as ours.

From Loughborough to Toton is 10 miles, and I began to think of supper, bath and bed. I was hungry; one is apt to be after fasting twelve hours on the footplate. I considered leaving the engine at Trent—why waste time carrying on to Toton at this late hour? But I decided to stay with the ship; I was reluctant to leave that warm and friendly cab for the unknown dangers that lurked in the black-out, being a stranger in a strange land. I plaintively intimated to the crew that I was starving; did they think anything could be done about it on arrival at Toton, supposing this ever took place? "Don't you worry—we'll see you get something," came the comforting assurance, and I knew all would be well. No engineman has ever let me down yet! We ultimately left the cab at 10.30 p.m., and I was led to the engine-man's hostel over an intricate path only to be safely threaded by the *cognoscenti*; here, hungry and thirsty, my soul fainting within me, I awaited the "something" promised by Pinder. Bread and cheese, or a boiled egg, probably my optimism went no farther than that. But no; like Sam Weller, I was invited to "a 'swarry,' consisting of a roast chicken and the usual trimmings." Pinder, if ever a fireman deserved immediate promotion, thou art the man. So ended my first "Garratt" experience, in the same atmosphere of good fellowship that I invariably find on the footplate. At 1.30 a.m. I retired to rest, lulled to sleep by a cheerful yard engine energetically pushing trucks over the "hump" just outside my bedroom window.

The return journey next day promised greater interest, as it was to be made with a fully loaded train, and Mr. Stanier had, I was told, arranged that an engine in really good shape should be at the head of it. It was "No. 7978," another "Garratt," also running bunker first, the crew being Driver Paraer and Fireman Pinnington. The start took place at 11.51 a.m., with a load of about 1400 gross tons. The gradient was slightly down and no sand was used; there was no slipping. The pressure was 190 lb., blowing off, regulator half open, cut-off 30 per cent. On the level, just beyond Trent Junction, we stopped to let another freight train get off the main line, on to which we were directed. The ample adhesive weight and cylinder capacity of the "Garratt" shows to great advantage at starting, which can be done gently yet firmly, as is necessary with a heavy train of slack-coupled stock.

At Seyston Junction there is a great sweeping curve, on which a 5 m.p.h. restriction is enforced, a curve of such magnitude that the full length of our eighty-seven-wagon train was in view from the engine, as it moved slowly round. Looking back from the cab, I noticed again the easy way the boiler unit shifted over to take up a position, inside the arc of the curve, both theoretically and actually a good feature. We had stopped before Syston, and our wheels again came to rest, for ten minutes, nearing Melton Junction; at Melton Mowbray we nearly halted, subsequently dawdling along in an attempt to avoid a signal stop, but in vain; the arm remained obstinately horizontal and we were forced to a standstill. Time, 2.19 p.m. It was raining, and blowing strongly; as the cab was very cosy, and our detention seemed likely to be lengthy, Pinnington filled in the time by serving afternoon tea, the live steam injector acting as the urn. Necessity the mother of invention! Another coal train was just ahead, its van only 25 yards in front of us, the two trains moving away together, until "No. 7978" stopped at a water column. There had been considerable blowing off since leaving Toton, owing to the frequent stops and slow travelling. The final restart was at 2.47 p.m.

The rising gradient to Saxby, 1 in 293, was taken on half regulator and 20 per cent. cut-off, at 12 m.p.h.; again blowing off occurred as we moved along at foot pace behind the other train to a signal stop. Wishing to discover whether the two engine units really did get into step, or if it were merely my ears playing tricks, I rode awhile on the platform in front of the smoke-box to settle the matter. It was even so—synchronisation apparently did tend to take place. Nearing Ashwell, another stop, on 1 in 282 up, restarting with half regulator and 60 per cent. cut-off and slight slipping due to the wet rails; the rise had been taken at 15 m.p.h. The following descent through Oakham to Manton, as steep as 1 in 139 through Manton tunnel, was made very cautiously, with shut regulator and much blowing off. So far, no records had been broken; 45 miles in 5 h. 20 min., 7·9 m.p.h. The line was congested with trains moving to London with the much-needed coal. Down through Glaston and Seaton tunnels, out on to Welland viaduct, the latter led to the foot of the heavy 7-mile pull up to Weldon, mostly at 1 in 200, through Corby tunnel, where I guessed Pinnington would have to show what he was made of.

Passing Harringworth at 5.34 p.m., well on the 1 in 200 gradient, we were going up at 12 m.p.h., on two-thirds regulator and 40 per cent. cut-off blowing off. At Gretton the speed had fallen to 10 m.p.h., Corby tunnel was in sight, the regulator was three-quarters and I felt this was no time to call the fireman's attention to anything; it was wanted

exclusively for his job. I may remind the reader he had four 18½in. cylinders to satisfy, and the 45 square foot grate called for everything he had—shovel, shovel, and again shovel, and, of course, at this vital moment a couple of big lumps must needs jamb under the brick arch, requiring a fire-iron to dislodge them. We were in Corby tunnel now and as "No. 7978's" thunderous exhaust reverberated from the wet walls of the murky cavern I became a fascinated spectator of a Homeric contest waged between Pinnington and the fire-box. The gradient was heavy, the load also, 1400 tons, and I began to look anxiously at the needle of the pressure gauge, which showed a slight tendency to recede. Which would win—fireman or fire-box? Pinnington was working like a Trojan, never pausing save to wipe his forehead, or seize the rake and level the fire, he kept that shovel going. A feeling of tension crept over me; I thought of those four cylinders, and of the insistent demand they were making for steam; the staccato exhaust beats sounded angry, menacing, exaggerated by the roaring tunnel echoes. That callous, telltale needle—it was completely unsympathetic. I wanted to help, but could do nothing but sit impotent, neither ornamental nor useful. But Pinnington was a good man, we emerged from the tunnel with victory in the air, Paraer shouting across the cab: "The worst is over when you are out of that hole!" and so it proved as we neared the peak just past Weldon. Both speed and pressure was rising, helped by the shortening of the cut-off to 35 per cent.; it had been a very heavy 7 miles, one of the worst stretches on the whole trip. The injector was put to work—it had been shut off during the ascent—and just after the summit was passed I was relieved to hear a defiant roar from the safety valves; the battle between Pinnington and the fire-box had ended in victory for the former.

With shut regulator the train ran gently down to Geddington, the live steam injector now adding its quota to the feed. The guard's brake was applied more than once, and again I was surprised to feel the responsive snatch on the engine—and enjoyed the crew's verbal reaction. By this time it was evident the fire needed cleaning, which had not been done since leaving Toton, and the Wellingborough stop, made at 7.40 p.m., gave the opportunity. Pinnington did most of the work, but I am sure he will admit I did my best to help with the ashpan part of a tiresome, dirty job, and if it is true that one volunteer is worth two pressed men, the result must have been of some value! My concentration on the task led me to overlook all else, even to the extent of forgetting that the adjacent track might conceivably be used by another engine, and that the roar of steam from "No. 7978's" valves would drown the sound of its approach. A sudden warning whistle from a light engine nearly in my back hair brought my vacuity home to me; only the driver's keen sight in noticing me moving in the glare of the raked-out clinker, amid clouds of steam, saved me. Failing this, a period would have been put to these locomotive experiences. On these "Garratts" the front part of the grate can be dropped, making it much easier to clean a fire, and side openings to the ashpan help when raking it out. Both good features—I should like to see the former adopted far more commonly in England. Watching a fireman lift clinker out through the fire-door on a long-handled shovel, and manœuvring it through the cab, to dump it alongside the track, is one of the little locomotive ironies that make me pensive at times. There are half-a-dozen air admission holes at the back of these "Garratt" fire-boxes, just above the floor, which I have never come across before; I do not know what their exact effect is.

A fresh crew came on at Wellingborough, which was left at 8.45 p.m. The benefit of the fire cleaning was at once evident, as during the heavy 1 in 120 climb to Sharnbrook summit, taken with full regulator and 35 per cent. cut-off, working pressure was fully maintained; in fact, blowing off took place. Things had been different before Wellingborough. The new fireman—I have not got the names of this crew—had a comparatively simple task. Here I was more than ever impressed with the crew's uncanny sense of location; in spite of the black-out in which I could see literally nothing through the impenetrable darkness, they never had the slightest difficulty in telling exactly where they were at any moment, or the degree of inclination, up or down. Sound reverberations or a rumble—they signified such-and-such a bridge; that vague outline, only just visible—a certain factory. Often when nothing whatever was visible—to me—they would mention some important landmark that actually was in being close to the track. They knew it all; I had to take it all on trust.

A long 5 miles drop from Sharnbrook summit, some of it as severe as 1 in 100, brought us near Oakley troughs, where water was picked up; Bedford followed, the train coming to a stand at 9.50 p.m., after which the very stiff 15 miles drag up to Leagrave was attacked, two-thirds of which is 1 in 200 or thereabouts, the steaming continuing to be very good, blowing off frequently punctuating the ascent, interrupted as it was by signal stops. Luton, just beyond the summit, was reached at 11.45 p.m., where I decided that nothing was to be gained by remaining on the footplate any longer. The night was as black as the pit, I was very tired and had difficulty in keeping my eyes open, so I retired to the guard's van, where, stretched out on a locker, I immediately became dead to the world until the guard's cheerful "Well, we're here!" attested our arrival at Brent—time, 4.25 a.m. The idea of negotiating the traps and pitfalls of the yard, *terra incognita* to me, was not attractive, so I remained in the van while it was shunted into a siding, resuming my slumbers until the pale light of dawn banished the black-out, and simplified my exit. Then, like Pepys, "And so home, not foxed, but weary and plaguy dirty, having fasted nigh upon sixteen hours."

The engines and their work, as I saw it, were very interesting, but the fact already mentioned, that they are demoded, and no longer typical of "Garratt" practice, even if they ever were, spikes my guns when it comes to criticising them. Why flog a dead horse?

These runs demonstrated the manifest advantages of the "Garratt" system and some of its good points, and if one or two things were apparently capable of improvement—well, the same thing applies to any and every locomotive; I have yet to come across a perfect one. I can truthfully say these oldish engines only enhanced my liking for the "Garratt" type, of which I have always been an admirer.

It would seem difficult to substitute any other type of engine on this particular service, curvature and weight restrictions being as they are. If non-articulated engines were called upon to handle these 1400-ton trains, nothing less than a 2–8–2 would do it, and from my recollection of the route they could not be operated over the severe curvature of the northern section. Double-heading was the rule previous to the advent of the "Garratts," which means that one boiler and engine crew now serve in lieu of two—the enginemen have probably noticed this.

"Oh, that mine enemy would write a book"—so says the author who gets his efforts slanged by the critic. I decline to go as far as this, but I am willing to outline an engine that would, I imagine, do even better work than those on which I travelled between Toton and Brent. I do so to prove (1) I really did notice things during these trips, (2) my notes were constructive, and (3) I have a sympathetic soul. The merits of the suggested design will be obvious—at any rate, they are to me—but anyone who is inclined to pick holes in it is perfectly welcome to do so.

Type	2–6–2+2–6–2
Driving wheels	4ft. 9in.
Cylinders (four)	15in. by 30in.
Heating surface:	
Superheater	750 sq. ft.
Total	3500 sq. ft.
Grate area	50 sq. ft.
Steam pressure	225 lb.
Tractive effort at 85 per cent. B.P. ...	45,300 lb.

Fire-box with two thermic siphons, rocking grate, cast steel frames

There it is. I cannot imagine any reasonable engineman quarrelling with these figures—I seem to be considering them first, as usual!—but should this unlikely thing happen, reduce the cylinder diameter by an inch and raise the pressure to 275 lb. If they still kick, and complain of overwork, fire them.

I am much indebted to Mr. Stanier for his courtesy in arranging the runs, and regret so much water has gone over the dam since they were made.

An Interesting Application of Automatic Boiler Control

By H. R. WALTON, B.Sc. Tech.

IT is generally possible to foretell how an automatic regulator, whether of pressure, temperature, flow, or other measurable quantity, will react to a certain combination of operating conditions, if its own characteristics are known. Since, in fact, former experience of similar problems is frequently available, the choice of the appropriate type of regulator for a particular duty may be determined in most cases by practice rather than by mathematical analysis of the various contributory factors. It is all the more interesting therefore to report on an installation where an analysis of the operating characteristics of the regulator had demonstrated that it was possible to apply it with success in a somewhat unusual manner to the automatic control of the steam pressure of a battery of boilers.

The steam pressure regulator employed in the control system described in the following report is the Electroflo, series "50" oil-operated regulator, and before describing the complete control system an understanding

of its operating principle will be helpful.

The arrangement of the regulator is shown diagrammatically in Fig. 1.

The diaphragm A is connected to the point where it is desired to control the pressure, and the force applied to it is balanced through the pivoted lever B by the tension of the spring S_1 when the controlled pressure is at its correct value. Attached to one end of the balance lever is a rod carrying a plate C, which governs the width of the gap between it and the orifice O_1. Oil at suitable pressure is supplied to the differential piston amplifier P_1 through the port D to the upper side of the piston, whence it flows through the fixed orifice O_2 to the space below the piston, and finally through the variable orifice O_1 to a drain.

The differential pressure for the balanced condition depends upon the areas of the piston, the size of the fixed orifice O_2 and the gap between the plate C and the orifice O_1. When the gap tends to close on an increase in the force applied to the diaphragm A, the rate of discharge decreases and the pressure

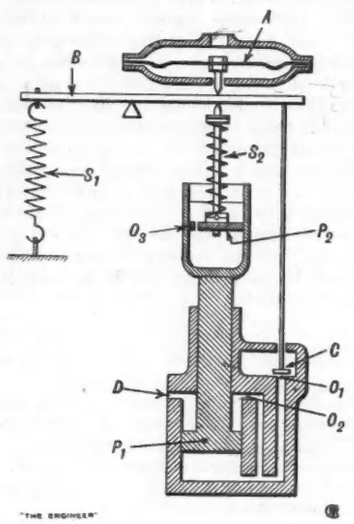


FIG. 1—ARRANGEMENT OF OIL-OPERATED REGULATOR

under the amplifier piston builds up, resulting in an upward movement of the piston. The piston moves in the opposite sense when the gap increases with reduction in the force on the diaphragm, allowing more oil to escape, since the pressure under the piston drops. It will be evident that there is only one setting for the gap between the plate and orifice O_1 for which the differential piston is stationary; that is, when the lever B is in its balanced position.

The piston may be connected directly to the control device which regulates the pressure, and continues to move in the appropriate direction until the pressure deviation has been corrected and the lever is in balance once more. When, as in the case of the installation under review, considerable working forces are necessary, the force and movement of the differential piston are magnified by means of a pilot valve and power piston with a suitable return motion lever, which, however, have been omitted from the diagram for clarity.

Attached to the amplifier piston is an oil cup or dashpot with a freely moving plunger P_2 connected to the balance lever by a spring S_2. An adjustable orifice O_3 is provided in the plunger and determines the rate at which oil can be displaced from one side to the other, and consequently its motion in relation to that of the dashpot. The combination of this motion and of the strength of the spring S_2 provides a reacting force on the balance lever which modifies the rate at which the amplifier piston is allowed to move in accordance with the deviation of the controlled pressure from its normal value.

It is not intended in this report to give a mathematical analysis of the reaction of the regulator to pressure deviation, but it can be shown that the rate of movement of the piston P_1 can be expressed by the equation

$$\frac{dV}{dt}=K_1 f+K_2\frac{df}{dt},$$

where V=displacement of piston P_1, or of the control device connected to it,
f=deviation of the force on the diaphragm A,
K_1=a constant, the value of which is a function of the size of the orifice O_3 and of the viscosity of the oil,
K_2=a constant, the value of which is a function of the rate of the spring S_2,
t=time.

This expression may be simply stated. The rate of movement of the regulator in response to a change of the controlled quantity from normal is proportional to the magnitude and to the rate of the change.

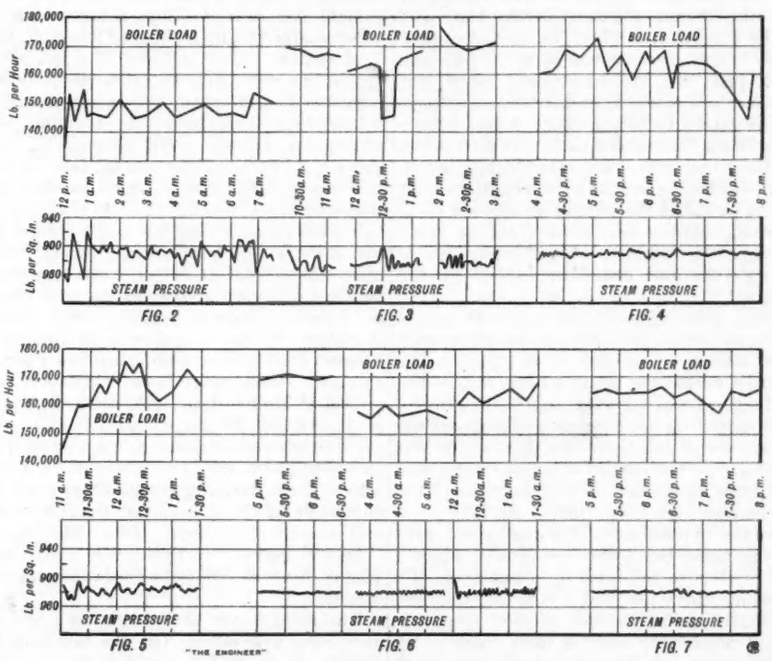
The second term of the equation has special significance when a delay or time lag exists between the movement of the control device (or of the piston) and the development of a corresponding change in the pressure experienced by the diaphragm A. It is well known that a regulator will in certain circumstances over-correct and cause the controlled pressure to oscillate above and below its correct value—being unstable and causing "hunting." Lag in the regulator itself can produce this, and a common source of "hunting" is insensitivity. Great sensitivity and rapidity of action may not always be sufficient to correct "hunting," however, and where the time lag in the control system, or "storage lag," is unavoidably excessive it is necessary to detect and react to not only the magnitude of the pressure change, but the rate at which the change is taking place at every instant, so that the corrective action may be continuously modified. A well-stabilised regulator may be said to resemble a damped instrument, such as a voltmeter, the pointer of which swings over the mark and then returns to rest at the correct reading.

Considering the case of a boiler, variation in header pressure occurs when the consumption of steam by turbines, heating processes, &c., is in excess of or less than the evaporation produced by the heat imparted to the boiler. In order to meet the demand for steam and at the same time maintain a constant pressure, the rate of heat input must be adjusted in accordance with the demand. With stoker-fired boilers and the usual draught arrangements, the interval between adjustment of stoker speed and air flow and the corresponding effect on the evaporation, and consequently header pressure, may be considerable, and hitherto it had been considered impracticable to make the regulators controlling the fuel feed and air flow responsive directly to header pressure changes. Serious hunting would be introduced. Most systems of automatic boiler control employ a system of air pressure loading whereby the fuel and air flow regulators operate at rates determined by air pressure, the latter being proportional to the load on the boiler.

Provided, however, that a regulator could be furnished sufficiently sensitive—for example, capable of measuring changes of a fraction of 1 lb. per square inch—and fulfilling the mathematical requirements as set out in the above equation, it was considered that steam pressure control could be satisfactorily undertaken by a regulator reacting directly to pressure and controlling the rates of fuel and air flow. It was therefore decided to install a control system operating on this principle.

Such a system is obviously simpler, in terms of the amount of equipment used than the more orthodox boiler control systems, though intrinsically more complex. It also lacks some of the flexibility which is a desirable feature of such systems. It is not, however, the purpose here to discuss any of its merits other than the ability to control satisfactorily a plant possessing considerable storage lag.

The plant consists of four Babcock and



FIGS. 2 TO 7—RESULTS OF TESTS

Wilcox boilers, each rated at approximately 100,000 lb. per hour, and operating at a nominal pressure of 900 lb. per square inch. Each boiler is provided with a chain grate stoker with a variable speed D.C. motor drive, and forced and induced draught fans with similar variable-speed D.C. drives. It was the intention to operate the stoker and induced draught fan motor rheostats by means of one regulator only; consequently, the rheostats for these motors were specially constructed, having a very large number of steps, and with their resistances so graded that each stud represented a given percentage change in speed. Since the motor speeds are directly proportional to the rates of fuel and air flow, individual setting of the ratio of the coal and air volumes supplied to each boiler is possible by shifting the relative positions of the rheostat arms, a manual adjustment being provided for this purpose. Owing to the grading of the rhetostat resistances, this proportionality of fuel and air is maintained over the whole working range.

The furnace draught of each boiler is individually controlled by a separate series "50" regulator, the power piston being coupled to the forced draught fan motor rheostat. These regulators possess the same operating characteristics as the one described above, but are independent of the pressure control system *per se*, and need not be considered further.

The steam pressure regulator is provided with a specially constructed measuring element, consisting of a bellows in place of a diaphragm, owing to the high working pressure, the force on the bellows counterbalanced by a pair of powerful springs. Movement of the bellows relative to the springs, due to change of steam pressure, is communicated to the balance lever of the regulator by means of a ligament, the other end of the lever controlling the opening of the variable orifice O_1 (see Fig. 1). The regulator responds readily to pressure changes of less than 0·5 lb. per square inch at the working pressure of 900 lb. per square inch.

The power cylinder of this regulator is arranged by means of a rack and pinion to rotate a shaft connected by chains and sprockets to the rheostats of the four induced draught fan motors and the four stoker motors. All the control equipment, including the four furnace draught regulators, are mounted behind a panel, the various rheostats being furnished with calibrated dials and pointers accessible at the front, enabling the fuel/air ratio for each boiler to be adjusted as described above.

During the following tests only two of the four boilers were in commission, the average total load being about 160,000 lb. per hour. The pressure for which the regulator was adjusted was slightly below 900 lb. per square inch, averaging about 880 lb. per square inch. The steam is supplied to turbines and the load reasonably uniform, but during the tests it was possible to vary the load in order to study the reaction of the regulators to these changes. In examining the results of the tests, illustrated by the accompanying diagrams, it is interesting to be able to compare the degree of pressure regulation under automatic control with that obtainable under manual control, and in Fig. 2 is a section of a typical day's record of boiler load and header pressure.

One of the factors necessary to determine the strength of the dashpot spring S_2 and so evaluate the factor K_2 in the control equation was a knowledge of the plant lag, *i.e.*, the time elapsing before a change in the speed of the induced draught fans would influence the header pressure. The lag was certainly of the order of several minutes, but load conditions did not permit of this factor being determined experimentally. It was, however, estimated at between 3½ and 4 minutes. In consequence, tests were conducted with a number of selected springs and with various settings of the dashpot orifice O_2 in order to determine the most suitable combination for the plant.

In Fig. 3 are shown the results of three short preliminary runs.

(*a*) Dashpot spring fitted having a rate of 20 lb. per inch deflection. Heavy oil was used in the dashpot with a small orifice opening. The dashpot reaction on the balance lever was, in consequence, fairly considerable, causing a slow rate of movement of the regulator to pressure changes. It will be noted that the resultant pressure record showed oscillations of fairly wide amplitude and low frequency, despite a relatively uniform load. The rheostat arms were moving slowly backwards and forwards without coming to rest or floating in some midway position.

(*b*) In order to accentuate the influence of the second or "rate" term in the equation, a lighter dashpot spring was fitted, having a rate of about 3½ lb. per inch deflection. The same oil and orifice settings were retained. The effect of the lighter spring was immediately apparent, and the regulator became much livelier. The record shows the resultant pressure. The effect of the sudden drop and rise in load will be noted.

(*c*) A further test was made with the same spring and a wider orifice opening. The first part of the record shows oscillations, which were, however, eliminated on reducing the orifice opening. The load conditions were fairly steady.

In Fig. 4 are shown the results of a run of several hours with a still lighter spring having a rate of 2 lb. per inch deflection. After the first half-hour, during which slight oscillation was observed, the orifice opening was reduced and a very satisfactory degree of control resulted, despite fluctuations in the load. The maximum pressure deviation was not more than 8 lb. per square inch, *i.e.*, approximately 1 per cent.

Fig. 5 shows the results of a test with the slightly stronger 3½ lb. spring replaced. The load during this test was made to fluctuate considerably, and at times the rheostat controls were moved to their extreme positions in the endeavour to check the sudden changes. Nevertheless, the pressure control was good, rarely departing by more than 8 lb. per square inch from its mean value. The settings proved a little critical, however, since, on slightly increasing the orifice opening, progressive hunting was produced, as is shown by the records in Fig. 6, and the rheostats were moving too fast.

The effect of increasing further the strength of the spring was then considered, and a spring having a rate of 5 lb. per inch deflection was fitted. The orifice opening was approximately the same as in the preceding tests. The results obtained were excellent, the maximum pressure deviation being 8 lb. per square inch, while over long intervals with normal load conditions the deviation was less than 4 lb. per square inch. A typical record showing the results of these settings is given in Fig. 7.

It will be evident from the above tests that this regulator is extremely flexible, and can be readily tuned *in situ* to the prevailing plant conditions. This is important, since it is rare that the exact time lag of the plant is known, and it is frequently impracticable to obtain this information by experiment. The choice of the correct rate of spring obviously plays an important part in the performance of the regulator operating under these and similar conditions, and it is of interest to state that the dashpot spring may be readily changed within a few minutes. The particular problem under consideration was admitted by the purchasers of the equipment to be a difficult one, and it was owing to their complete collaboration that such gratifying results were so readily achieved.

Science and World Order

No. I

AT the meeting of the British Association for the Advancement of Science, which was held in Cambridge three years ago, a Division for the Social and International Relations of Science was formed. The main purpose of the Division is to further the objective study of the effects of the advances of science upon social conditions, and to promote the welfare of human communities through international understanding of them. The war, of course, has brought the annual meetings of the British Association to an end for the time being, but in view of the conditions which are likely to arise after the war, it was decided to hold a Conference on Science and World Order under the auspices of the Division for the Social and International Relations of Science. The original idea was that the Conference should be on a small scale with a few papers, but the welcome given to the suggestion proved so great and widespread that it was broadened into a three days' Conference with two three-hour sessions per day. This Conference took place on Friday, Saturday and Sunday, September 26th, 27th and 28th, and the crowded attendance on all three days in the famous lecture hall of the Royal Institution, Albemarle Street, London, more than justified the step that was taken.

The Conference has attracted world-wide attention already and the determination to go forward, after the Conference, on practical lines in order that the discussions that took place should not just end there will ensure that this widespread attention shall continue so that the many ideas that were put forward may have some chance of being put into effect. There were present scientists, economists, engineers and statesmen from practically all the countries of the world, except, of course, the Axis countries, and it was for this reason that the chairmen of the various sessions included representatives of Great Britain, Russia, America, Czecho-Slovakia and China. Naturally, scientists from Russia could not arrange to be here, and it had been their intention to send messages to the Conference over the radio, but this was rendered impossible by jamming on the part of the Germans. Nevertheless, a message was received from the Academy of Science of the U.S.S.R. A recording was also given of a speech by Field-Marshal Smuts from South Africa.

In such a gathering it can well be imagined

that the field covered was comprehensive. A great deal that was said was of an idealistic nature ; some of it was by way of generalities, but behind it all there was by far a larger desire to be practical and to have immediate action. Although it might be inferred that such action was intended to be taken after the war, it was strongly urged that the preliminary steps towards the planning of a new and constructive order should be taken now and it was announced that committees would be formed immediately after the Conference, to this end.

With such a mass of discussion to deal with it is only possible to record the outstanding points of direct interest to science and engineering. There are other aspects, such as medical, post-war relief, agriculture, and so on, all of which must receive consideration in any scheme of post-war reconstruction, or perhaps it should be called construction, for it is hardly the desire to reconstruct on the old foundations, but to build anew.

In the following notes are recorded some of the matters of more direct interest to the readers of The Engineer without reference to the particular session.

The opening of the Conference was in the hands of Sir Richard Gregory, and throughout the whole of the sessions there was the constant taking of photographs and cinematograph records of the proceedings.

Reference may here be made to the address with which M. Maisky, the Soviet Ambassador, opened one of the sessions. In the course of it he said :—" There will undoubtedly come a day when the system of very comprehensive planning — economic, social, political—will embrace the whole globe. But that day is not yet very near. I come from a country where planning is the very foundation of its economic life. In this the Soviet Union has reached already avery considerable degree of perfection, and it was no easy matter. It took us more than twenty years to build up the present system of planning in spite of the fact that since the early days of our revolution we had not to reckon with the difficulties which originate from the existence of private property on means of production and distribution. Such was the position in a single country with a strong and unified central administration. How much more difficult it will be to bring about economic planning on a world scale ! How long it will take to create the necessary prerequisites for the success of such planning. Obviously this is a matter not for to-day or even to-morrow."

Sir Richard Gregory, before opening the session on Friday morning, read the following message from the Prime Minister :—

" I regret that I am not able to be present at the opening of your Conference. One of our objects in fighting this war is to maintain the right of free discussion and the interchange of ideas. In contrast to the intellectual darkness which is descending on Germany, the freedom that our scientists enjoy is a valuable weapon to us, for superiority in scientific development is a vital factor in the preparation of victory. The presence of the representatives of so many different nations is striking proof of that universal desire for liberty of thought which all the power of the Gestapo will never entirely wipe out. It will take a long time for the civilised Powers to repair the trail of material and moral havoc which the Germans leave behind them. It will require all the resources of science. But I look forward to the day when the scientists of every nation can devote all their energies to the common task, and I wish you every success in the work you are undertaking now."

Sir Richard also announced that a message had been sent to His Majesty the King :—

" The President of the British Association, with humble duty, begs leave to bring to the notice of His Majesty the King the Conference of the Association's Division for the Social and International Relations of Science, which opens to-day for the discussion of the place which science should find in world order, its relations with the democratic state, its contributions to the relief of human needs and suffering, its potentialities in connection with the just distribution of world resources, and the influence which by its example it should bring to bear in directing the minds of men towards peaceful collaboration in future for the common welfare.

" In conference with members of the British Association and other representatives of science, administration, and education in this country, there are present many who have come to us from your Majesty's Dominions and other lands, and assuredly such an occasion as this will help to strengthen the bond between the free peoples.

" That such a Conference should be held here at such a time we take to be a fortunate symbol of that freedom in the pursuit of knowledge which we ourselves treasure and are striving to restore to all those who now are deprived of it."

Opening Address

The Chairman, in his opening remarks, said that that Conference differed in its character and outlook from all others convened by scientific and technical bodies to deal with their special subjects and interests. It was an assembly in which some world problems would be presented from scientific points of view by men who had given close attention to them, with the desire to assist in the planning of the new world order which would increase in strength and security through progressive scientific discovery. The Conference represented the common purpose of many men of science to take an active part in the construction of a new framework of civilisation in which the full services of their discoveries would be made available to improve the conditions of life. In the Commonwealth of Science there were no social, racial, or geographical distinctions, and that was the spirit of the Conference. The aim was to seek a common understanding of what science could do for the betterment of the human race, and authority to assist in the control of forces now used to degrade it. There could be no compromise between a Commonwealth like that in which free men of science were associated in the pursuit of knowledge and the powers which were making truth and righteousness a mockery. The anguish which the world was suffering to-day was due to the perverted use of knowledge and the rejection of all high ideals. The cause for which men of science, faithful to their high principles, were now fighting with steadfast purpose was that of all humanity. The call was to the heart, and the need was for the active co-operation of all peoples who prized their freedom and believed in the maintenance of fundamental human rights. Faith in that cause and confidence in the united strength of free peoples to repel all assaults upon it, would ensure victory over its enemies. The road along which the enemy exulted in travelling was one of blood and tears, with the object of dominating the world and destroying the spirit of freedom and fellowship by which life on the earth was made worthy of man's power and destiny. Because of unity of belief that that spirit would prevail over the attacks now being made upon it, and that a new world order was possible in which the resources of science would not be prostituted, this Conference met to offer schemes of reconstruction designed to make scientific knowledge a blessing instead of a curse.

It was added that, knowing the difficulties which the British Association had to overcome at the present time, and as an expression of goodwill to support its activities, the American Association for the Advancement of Science had sent the British Association a few days ago a cash balance of 539 dollars remaining over from their last annual meeting.

Science in War

The Right Hon. Lord Samuel spoke of the methods at present functioning in this country in the development and use of science in the war, and repeated a suggestion which, he said, he had made some time ago, but which did not meet with much favour, that scientists should be attached to all our Embassies in other countries. There should be appointment of scientific men whose duty it should be to keep a constant watch on invention and methods of organisations in the other countries of the world likely to be of value here, in order to bring them to the attention of the proper authorities. It was true to say that science was not now undervalued in this country as it had been. How far the methods at present functioning in this country in the development and use of science in the war were functioning efficiently and how far they were adequate for their purpose, he would leave others to say. The Parliamentary Science Committee kept a watch in that respect, and reliance was placed upon that Committee to do the necessary prodding, goading, and, if necessary, the belabouring of the authorities in order to secure the maximum efficiency. The prime object at the moment, obviously, was to win the war, but it was the task of those who were not privileged to take an active part in it to deal with the problems that would inevitably arise afterwards. Steps to that end were necessary even now, and a certain amount of planning had already been done or was being done. There was need for much more scientific activity than had hitherto been forthcoming in regard to such matters as the planning of town and country, and especially in the planning of buildings and the materials of construction. Many architects were now giving their minds to that subject, and an Architectural Science Board had been formed. He also referred to the fact that, as the result of political persecution, there are now working for the Government in this country a number of specialists whose work in the laboratories was proving of the greatest possible value.

Science in Government

An outstanding contribution in the early part of the Conference was that by Professor A. V. Hill, M.P., Secretary of the Royal Society, who dealt with " The Use and Misuse of Science in Government." We give this in full elsewhere.

The Tennessee Valley Development Scheme

Dr. Luther Gulick, of Columbia University, gave an account of the work of planning and development of the Tennessee Valley which started a few years ago, and is still going on, and referred to it as an example of what could be done elsewhere as a part of post-war planning. He described how many years ago individual settlers nearly ruined the valley and themselves by their uncontrolled and unco-ordinated methods, and how the average income of each settler was not 100 dollars a year. Then the Federal Government came along, and eventually the

Tennessee Valley Act was passed. It placed the administration of the whole of the huge valley, consisting of seven States, under a Board which adopted twentieth-century methods of science and technology in the development of the area, working in co-operation with local bodies. One of the outstanding features of the development has been the construction of water power schemes and dams. Six large dams had been completed and were now in operation, three more dams were well in hand, and were scheduled for completion in 1944. The capacity of the water power stations already in operation was 1,000,000 kW, and will be increased to 2,000,000 kW in 1944. The output in 1940 was 6,000,000 units, bringing the Tennessee Valley power stations to sixth place among the power systems in the United States. He said that eight years' experience in the Valley had demonstrated that in the case of public power supply low rates to the consumers and a reasonable return on the taxpayers' interest were not incompatible. Moreover, low rates for electricity were good business. Those schemes were started in 1933, and they were developed in parallel with a programme of social improvement. In all that work leading engineers and leading social scientists had co-operated, whilst the universities were also contributing to the effort. He forecast that ten years from now the Tennessee Valley improvement scheme would present one of the most striking planned evolutions in social history, and he put that scheme forward as an example of the type of planning that should be carried out in many parts after the war.

HEAT AND POWER RESOURCES

Sir Harold Hartley (Chairman, Fuel Research Board) spoke on the subject of world heat and power requirements and their social implications, which, he said, must be included in any discussion of the relation between science and human needs. Since the utilisation of energy had played such a vital part in increasing productivity and the standard of living in the past, it should be an equally important factor in the period of reconstruction which now had to be planned. The achievements of power, said Sir Harold, were too often dismissed with picturesque phrases without quantitative consideration, and he pleaded for a detailed consideration on a quantitative basis of the energy problems and possibilities involved in any schemes of reconstruction.

After giving statistics of the world annual consumption of coal, oil, &c., from 1820 to 1900, and indicating how this had improved living conditions generally, he said that it was the fact that the majority of the inhabitants of the world were still living on a miserably poor level, far below what we have come to regard as the minimum of physiological requirements. What, he asked, can science do through the utilisation of energy to help to solve the immediate problem of reconstruction, and what are the long-range problems in the field? The immediate problem was to raise the world's productivity, particularly in the backward countries, and to secure the equitable distribution of the products in relation to the needs of each country, thereby eliminating the waste of energy involved in the search for self-sufficiency within arbitrary geographical boundaries. The initial stimulus must come from the technical resources of the developed countries, and might entail a quick and lavish expenditure of energy and resources. But in replanning, conservation must be the guide, for in spite of large world resources of fuel, these would become increasingly more inaccessible. The energy problems in the developed countries were relatively clear and simple and technological progress would continue to solve them. Maximum economies must be obtained in the winning and distribution of fuel and in its utilisation, with the constant objective of making energy cheaper and more generally available. The generation of electricity by means of condensing turbines must always involve considerable heat losses. One remedy for that was regional planning with a view to securing, as far as possible, the joint use of heat and power, the heating being done by steam extracted from the turbine after partial extraction, thus saving the losses due to expansion. The carbonisation of raw coal and the use of electricity in some co-ordinated scheme, designed to secure the maximum advantages from both, would help to solve the problem of smokeless cities, and would provide the cheap energy required in the homes of the future.

One of the major problems of developed countries was the inequality of conditions in the town and country. Agriculture still retained much of its primitive character. Wider application of energy on the farm and in conditioned transport and storage would increase productivity, ease the conditions of life and accelerate the processing of farm products, a development now in its infancy. Experience in Canada and America had shown how much the tractor, the motor vehicle and electric power could contribute to higher standards on the farm.

Over half the 2000 million people of the world lived in the less developed countries and depended mainly on agriculture. Their energy problems were much more urgent and difficult. In the most backward countries, where many millions were existing on subsistence agriculture isolated from any means of helping themselves, the first need was cheap transport adapted to the needs and energy resources of the particular region. In the less primitive countries, the problem became relatively easier, but the elements remained the same—improved transport and communications, better means of storage and marketing, power-driven machinery, the processing of products, and every means of raising productivity without impairing the fertility of the land.

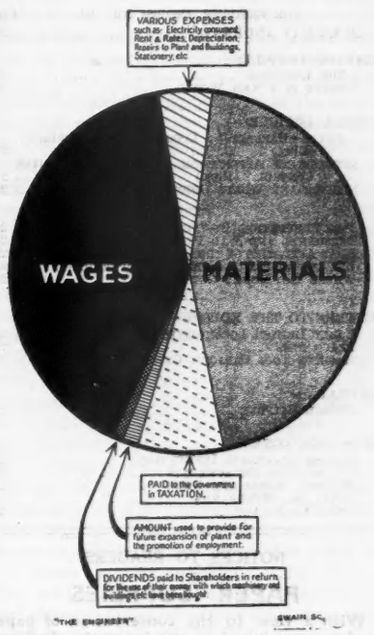
These were the immediate problems which required rapid and intensive attack when reconstruction was possible. With the scientific knowledge we now possessed of standards of consumption it should be possible to plan with much greater certainty than in the past. Meanwhile we could leave to fundamental research the longer-range problems, confident that it would yield continuing improvements in the utilisation of fuel, in the distribution and storage of electricity, in the uses of power and in the production of substitutes for mineral oil from coal or vegetable products against a possible shortage. The ultimate goal was the utilisation of the sun's radiation currently by some photochemical or photo-electric device or engine to take the place of the energy stored in coal and oil. Those were the long-range problems to be solved in the days to come, when once more it could be said that science knows no frontiers. The immediate task was to ensure that in the replanning of the world full use was made of the basic knowledge that science alone could provide, particularly in the fields of nutrition and energy with all they implied, for the wellbeing of mankind.

(To be continued)

LIEUT.-COLONEL SIR JOHN GREENLY has been nominated President of the Institute of Metals for 1942–43.

Where the Money Goes

WE take from *Contract*, the journal of the David Brown group of companies, the following diagram. There is little or no editorial explanation or discussion of it, but we may perhaps be allowed to point out that the firms which supply


VARIOUS EXPENSES such as: Electricity consumed, Rent & Rates, Depreciation, Repairs to Plant and Buildings, Stationery, etc
WAGES
MATERIALS
PAID to the Government in TAXATION.
AMOUNT used to provide for future expansion of plant and the promotion of employment.
DIVIDENDS paid to Shareholders in return for the use of their money with which machinery and buildings etc have been bought

the materials would have similar charts, so that the total volume expended as wages would occupy more than three-quarters of the total area of the circle. The smallness of the total turnover paid out in dividends is striking. Presumably, "wages" includes salaries.

FIRE PREVENTION (BUSINESS PREMISES) No. 2 ORDER

THE new Order, which came into operation on Monday, September 22nd, differs substantially from the old Order on a number of important points, but the general basis remains the same—that is, that occupiers of premises in areas to which the Order has been applied by the Regional Commissioner must make adequate arrangements, which may be on a voluntary or compulsory basis, and notify them to an appropriate authority. As for the workers employed at the premises, unless there is a voluntary arrangement, all men between eighteen and sixty years of age, with certain exceptions, are under an obligation to perform fire-prevention duties up to a maximum of forty-eight hours per month outside working hours. There is an important change at this point. If a man does less than forty-eight hours' duty under the Business Premises Order he may be required under an amendment of the Compulsory Enrolment Order to make up the balance in the area where he lives. The definition of business premises remains the same, except in regard to shops. An important part of the new Order deals with the provision of sleeping, washing, and sanitary facilities. There is now an obligation on the occupier to provide these, whereas formerly this was a matter of recommendation, and the provisions for consultation with workpeople have been extended. The new Order establishes subsistence allowances on a fixed scale as follows:—For a continuous period of fire prevention duty, outside working hours, not exceeding twelve hours, 3s.; for a continuous period exceeding twelve, but not exceeding eighteen hours, 4s. 6d.; for a continuous period exceeding eighteen, but not exceeding twenty-four hours, 6s. The cost of these allowances will be defrayed by the Exchequer.

The Engineer

OCTOBER 3, 1941

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NOTICES TO READERS

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CHANGES OF ADDRESS

**** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both old and new address,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

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The Engineer

FOR nearly eighty-five years THE ENGINEER has been printed in its familiar large format. To have to change it is bitter. Apart from its merits and advantages, the size is dear to us; we cannot part with it after all these years without regret. The attachment of a newspaper staff to its "old rag" is traditional, and it is true too. Any change is anxiously scrutinised and even when it may be for the better is jealously regarded. Still greater is the anxiety when a change has to be made not for the sake of improvement, but under the pressure of necessity. Such necessity has fallen upon THE ENGINEER. Our supplies of paper are limited to a fraction of what they were before the conquest of Norway and the Battle of the Atlantic. We were thus faced with the dilemma, either to ruin our appearance by trimming edges to the bone or to preserve appearance and boldly adopt a smaller page. We decided to take the latter course, but as a concession to the memory of the format that we had borne so long we have made the new paper an exact reduced replica of the old. It will still look like THE ENGINEER of old, though its stature will be less. We shall endeavour to keep the old make-up and to use a type face that can be read pleasantly. Thus we shall pay homage to THE ENGINEER of its founder eighty-five years ago.

Our regret at having to depart from our old pages would have been less could we have made the change at the beginning of a new volume. Unfortunately, the restriction has been so suddenly imposed that an immediate change is necessary. Hence half the current volume will be printed on a smaller sheet. This has given some concern to the libraries and institutions which bind THE ENGINEER, and after consultation we suggest to them that they should bind the two sizes together in the same case. As a matter of fact every library has examples of that kind of binding, as, for instance, when a number of pamphlets are all bound together, despite disparity in size, in a single volume. The whole volume will, we have to admit with regret, be so thin—few pages on thin paper—that this arrangement will put no undue stress on the binding. Furthermore, only one case, and one bill for binding, will be needed instead of two. As we are confident that librarians generally will adopt this suggestion, the index with title page will be printed on the old size, so that, as usual, it may be stitched in at the front of the volume. The pagination will be continuous from July to December.

In conclusion, we may say that we shall endeavour to make THE ENGINEER in its new form as useful and attractive as our old friend. Happily, we believe that the change will actually be welcomed by many, amongst whom are advertisers as well as readers.

Science in a New World

THE world is stirring towards a new birth. Men are seeing visions of a new world; a world in which poverty will be unknown, in which all will be gainfully employed, or, if not, will be supported in adequate comfort by those who are; in which there will be no sordid homes, no dirty ill-nourished urchins, no cricket in back streets, no uneducated people; no wealth rolling ostentatiously in motor-cars, no stately homes with unused rooms and wide acres, no private capital, no interest, no savings; no anything that has formed part of the fabric of the society which it has taken centuries to build. In short, if the demands of all the reformers are met, there is to be a complete demolition and rebuilding on a new plan. What is that plan to be? How is it to be directed so as to avoid the excesses of ill-directed enthusiasts on the one hand, and on the other to leave to individuals and nations so much of their autonomy that their best qualities may have room for development? To that question the British Association endeavoured to make answer last week-end, and its answer was "Science must prevail in all branches and aspects of human enterprise and endeavour."

There has gradually grown up a larger view of the *rôle* of science in the world. Science is no longer merely the discovery and enunciation of natural laws. It now concerns itself with human philosophy as much as with natural philosophy. The B.A. week-end gave a great deal of its time to what are, in fact, economic questions. It debated plans for the future, though Mr. Maisky reminded us that we must take first things first, and direct all our scientific knowledge and technical capacity to defeating Hitlerism. Assuming that that will be done, how is mankind to set about the regeneration of its world? By employing the resources of science internationally, not for production alone, but for distribution as well. There is a confirmed belief that if international agreement upon the exploitation of natural resources can be reached, then so great are the devices of science and technology that no individual in any corner of the inhabited globe need suffer from the want of anything that may make for his contentment. Indeed, so great are the possibilities, that, given a free hand, science will make it unnecessary for anyone to work more than two or three hours a day, the remaining hours being given up to sleep and the increase of intellectuality and culture. It is recognised that to attain this end the whole world must work in harmony. There must be no national rivalry, but every nation must be part and parcel of a happy and united world commonwealth. Science, it is averred, is the cement that can bind the diverse elements together. Already it refuses to recognise national frontiers. All those who pursue science are united in a common brotherhood. If only this brotherhood is permitted to exert the great power that is inherent in it, then it will so sway the kings, princes, emperors, and governors of the world that wars will for ever be a thing of the past, and the blessings of peace will lie like a mantle over all. To reach that, still visionary, desideratum the world must plan and plan and plan, always under the direction and control of Science. National interest, like self interest, must be subordinated to plans prepared years in advance. In fact, through the administration of Science, every nation under the sun is to direct its resources in the right amount at the right moment on to a vast, world-wide assembly belt, which will distribute the products to all mankind.

That is the vision. How nearly can it be realised, who shall say? Mr. Maisky, himself a great advocate of planning and an observer of the greatest experiment of that kind that has ever been attempted, warned the British Association not to expect too much too quickly. If it was difficult in a newly swept Russia, "how much more difficult it will be," he exclaimed, "to bring about economic planning on a world scale!" The warning was needed, for there are not wanting enthusiasts who believe that by taking thought—and action—a new world may be instantly created upon the ruins of the old. They have forgotten already the promise of "a world fit for heroes to live in" that followed the last war. Nothing that is great is ever achieved quickly. The old forces, inbred in human nature, cannot be swept aside in a day. National genius cannot be converted into international genius at the command of the scientific-planner. Rivalries and animosities will still remain. Man will yet be man whatever the scientist may devise. But he may, nevertheless, move ever towards a higher ideal and in that movement he may be assisted by the wise directions of science.

Obituary

GEORGE BALFOUR

BY the death of George Balfour, which took place in London on Friday, September 26th, at the age of sixty-nine, the British electric supply industry and the allied business of civil and electrical engineering contracting has lost a leader who combined in an outstanding degree engineering training and ability with administrative and business experience, and whose loss in these difficult days the nation can ill afford. It was only last week that George Balfour was returning from a short stay at his estate at Foss, Perthshire, to London, when he was taken ill in the Station Hotel at Perth. With his usual determination, he insisted on continuing his journey to London. During the night, however, the illness continued to develop and on reaching Euston he was taken from the train in an unconscious condition. He was quickly removed to the London Clinic and was visited by Lord Dawson of Penn, but in spite of every care he did not regain consciousness, and died peacefully on Friday night.

GEORGE BALFOUR

He was born at Portsmouth on November 30th, 1872, and received his early education partly at Portsmouth Technical Institute, and partly at Dundee University College. His engineering apprenticeship was served with the Dundee firm of Urquhart, Lindsay and Co., with whom he remained for some years after his apprenticeship was finished. His next position was with the electricity department of Edinburgh Corporation, where he continued his electrical training, and he then joined the firm of Lowdon Brothers and Co., Ltd., electrical and mechanical engineers, of Dundee, becoming at a later date a director of the firm. In 1903 he left Dundee to come to London, where he took up a position as commercial engineer with the firm of J. G. White and Co., the British branch of the J. G. White Corporation of New York, which was engaged largely in tramway construction. That work brought George Balfour into direct touch with electrical development work in this country at a time when but little capital was available for such business. Before he left J. G. White and Co. he acquired the control of the Arbroath Electricity Supply Company and the Dundee and Broughty Ferry Tramways Company, concerns which he reorganised and made into prosperous undertakings, although at the time he acquired them J. G. White and Co. did not regard them as attractive propositions.

About 1909 he formed his own company of Balfour, Beatty and Co., Ltd., for the carrying out of electrical supply undertakings. From the first he clearly saw the possibilities for future electric supply developments in Great Britain, and formulated plans which were all the more definite by reason of his association with the J. G. White Corporation and his first-hand knowledge of the progress then being made in America by United States power supply companies. Two of the first Scottish companies with which he was connected were the Fife Power Company and the Scottish Central Power Company, which he greatly developed and then amalgamated to form the Scottish Power Company, which after the last war obtained the rights to carry out the Grampian power schemes.

In 1913 George Balfour became interested in the group of Midlands supply companies, which comprised the Derbyshire and Nottinghamshire Electric Power Company, the Leicestershire and Warwickshire Electric Power Company, the Nottinghamshire and Derbyshire Tramways Company, and the Leamington and Warwick Electrical Company, Ltd. These, with additional properties and extended powers, were combined in 1921 to form the Midland Counties Electric Supply Company, Ltd.

He was also interested in the Llanelly and District Electric Supply Company, which is managed by Balfour, Beatty and Co., Ltd.

In London he was associated with the Metropolitan Supply Company, Ltd., first as a director and later as chairman. It may be recalled that the power stations of this company were transferred to the London Power Company when that undertaking was formed and George Balfour became a director and its chairman.

In 1922 the Power Securities Corporation was formed, and it acquired the interests of Balfour, Beatty and Co., George Balfour remaining the chairman of the concern.

On the civil engineering contracting side his firm has carried out several notable works, amongst which the Lochaber scheme, for which Messrs. C. S. Meik and Halcrow, are the consulting engineers, may be specially mentioned. The work included the construction of a 15-mile long tunnel under Ben Nevis from Loch Treig, and the breaking through of the tunnel some 110ft. below the surface of the water. For the Grampian power schemes the firm undertook not only the work of construction, but also that of design. Both those great Scottish power schemes have been fully described in our pages.

Not only in this country but abroad was the name of George Balfour well known. When the Perak River Electric Power Company, Ltd., encountered difficult days, the Treasury invited Balfour to advise as to the future development of the undertaking. The scheme of reorganisation and financing which he recommended was accepted and carried through, and to-day the company is doing extremely well. In the Argentine George Balfour was well known as the deputy chairman of the Atlas Electric and General Trust, Ltd., a company which brought him into touch with many South American interests.

Mention should also be made of the irrigation work carried out by Balfour, Beatty and Co., Ltd., in Iraq, especially the Kut barrage, which was constructed between 1934 and 1938 for river regulation, and has been fully described in THE ENGINEER. At the speech he made at the official opening of the barrage George Balfour rightly referred to the country of Iraq as an irrigation paradise. The company, shortly before the war began, secured the contract for the construction in the same country of the Habbiniyah scheme for river regulation developed by the consulting engineers, Messrs. Coode, Wilson, Mitchell and Vaughan-Lee, and described in our pages at that time. It will entail the excavation of some 7,000,000 cubic metres of material in the building of the canals.

Alongside his many company activities, George Balfour found time for parliamentary work, and in 1910 contested the Govan Division of Lanark, and from 1918 until his death was the Unionist Member for Hampstead. In the House of Commons his speeches (like those delivered to his companies) were mainly concerned with financial and industrial matters, but they were always valued for their content. He was a valued servant of the Government, and we may recall that Lord Reith invited him to preside over the committee which he appointed to inquire into the working and production of the cement industry. He was a member of the Institution of Mechanical Engineers, the Institution of Electrical Engineers, an associate of the Institution of Civil Engineers, and a member of the Institution of Engineers and Shipbuilders in Scotland.

In the course of his interesting and very successful career, George Balfour made many friends and gathered around him a team of loyal workers. He was unchanged by his success, and all those who were privileged to know him and to share his friendship will mourn his loss deeply.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

EARLY BRITISH LOCOMOTIVES

SIR,—The most recent results in unravelling certain of the problems connected with the very early stages in the evolution of the locomotive, described in Mr. Dendy Marshall's letter in THE ENGINEER for June 20th, 1941, are of considerable interest, and the outstanding matter is the suggestion by Mr. Forward that the eight-wheeled locomotive generally attributed to Hedley was, in reality, a Chapman design. Reviewing this suggestion, there can be no doubt that, except for O. D. Hedley's book of 1858, the more or less contemporary published information is far more in favour of attributing the design—but not the actual engines represented in the drawings—to Chapman than to Hedley.

Before dealing with the literary sources, however, the writer would approach this question from the point of view of the object desired to be achieved by the constructor—in other words, first principles—and by a scrutiny of the drawings.

The practical object in placing the locomotive upon four axles must have been the lessening of the weight per individual axle and/or the provision of flexibility to enable the locomotive to pass round curves. Now the former object could have been partially achieved by placing the engine upon two subsidiary frames, similar to those shown in the illustrations, and allowing each subsidiary frame to rock in a vertical direction about a horizontal laterally placed axis provided at the contact between the cross members (body bolsters) of the main frame and

the cross member (truck bolster) of each subsidiary frame; but which is not so shown in the drawings, and, in fact, was a principle only adopted in Chapman's own patent of 1827 for wagons. If the railway for which the locomotive was required was practically without curves, it might be considered that the foregoing was the true explanation of the design, but that N. Wood says: "The transverse supports K K are fastened to each of the frames H H and I I by bolts in the middle, which allow a lateral motion in the frames to conform with the occurrence of curvatures in the line of road," and the provision of this without a pivot would have been a mechanical fallacy, and (quite obvious to Wood) certainly not allowing the subsidiary frames to "conform." Besides this, if only lateral movement as described had been provided, apart altogether from the jamming and consequent likely derailments, there would have been nothing to bring the engine back to fore-and-aft trim after passing a curve. Hence *a priori* pivots are an essential part of the design.

Turning now to the drawings—from the point of view of "bogie" or "non-bogie," they are all identical—an entirely opposite deduction appears inevitable. The chocks in which the lower transoms sit are directly over the side frames of the bogies, close inside the wheels, and also the positions of the various gear wheels are such that there is insufficient room for cross members to have run from chock to chock or laterally between the subsidiary side frames themselves, except at the extreme leading and trailing ends of the engine. Hence, there is no possibility of swivelling movement having been provided, as even if there was liberty in the chocks for the "transverse bearings" (K K of Wood's drawing) to move laterally the friction would cause the side frames to rock laterally upon the axle bearings instead of the "transverse bearings" moving in the chocks.

Wood, however, whilst stating that there was lateral motion between the "transverse bearings" and the subsidiary frames, gives no clue as to how the upper frame was connected to K K, merely saying "G G is a square frame of wood on which the boiler is supported by the upright transverse bearings K K." There thus appear to be transoms of the main frame above the transverse bearings K K, and the shading under the rear end of the frame G G indicating that K K were considerably shorter than the width from out to out of the longitudinals of the frame G G, supports this, and the obvious—and only—location of the pivots would be between the end beams of the frame G G and the transverse bearings K K.

The foregoing is evidently building upon a manifestly "sketchy" drawing, very little elucidated by Wood's description, and the only reasonable verdict is that the parts as shown indicate a system of framings without adequate provision for either lateral or swivelling motion to the "bogies." In other words, mechanically incorrect for its intended purpose, and thus if it had been built in that form it would have suffered racking strains upon curves leading to early failure of its parts. Hence the writer can only consider it an approximate diagram, a probable reason for which circumstance will be mentioned later on.

It should be mentioned that the fitment which Mr. D. Marshall considers might have been mistaken for a bogie pivot pin is obviously a footstep—in Wood's illustration will be seen its accompanying hand pillar and corresponding driver's seat—and has nothing to do with the elucidation of the problem. The first suggestion of its having misled engineers into supposing it was a bogie centre pin (!) appears to have been by Ahrons in 1925. Note also that there would have been no practical difficulty in allowing for swivelling bogies by suitable provision in the engagement of the gear wheels.

Having exhausted the indications derivable from first principles and from the only available drawings, it must be concluded that at least one of the subsidiary frames was a pivoted bogie, and if one was so, it is probable that both were. The possibility, however, of only one of the subsidiary frames being a swivelling bogie must not be entirely ruled out, for the reason that Chapman's patent of 1812, as also the "Butterley" drawings of 1813 (the writer has established that the "Chapman" bogie locomotive drawings, published in THE ENGINEER, September 4th, 1936, derived from the Butterley Company) show a locomotive vehicle partly on a bogie and partly on one fixed axle.

Reverting now to the question of who was the designer.

The *Repertory of Arts*, &c. (February, 1815), which is the oldest reference known to the writer, definitely states: "Account of a locomotive engine executed by Messrs. Chapman, according to their patent dated December 30th, 1812. On November 21st, 1814, a locomotive was set to work on the wagon way of J. G. Lambton, leading from his collieries to the River Wear. The engine was mounted on eight wheels. The acting power of the engine was applied to the wheels supporting it. . . . It could not have moved the present numbers of wagons up a greater ascent without having recourse to the second part of Messrs. Chapman's invention, which consists in having a chain laid along the way." This is exactly applicable to the 0-4-0+0-4-0 engines, and from the specific reference to not having had recourse to the second part of Chapman's invention, the inference is clear that the other—*i.e.*, bogie—part was used.

Hebert (1837) devotes a long paragraph to Messrs. Chapman, in which, after describing their 1812 patent and its two features, both the chain system and the method of lessening axle loads, he cites the failure of the chain system on the Heaton Colliery line. He then goes on to say: "The annexed engraving exhibits an elevation of one of the locomotive engines of Messrs. Chapman, which was employed on the Heaton Colliery," giving a left-side view of the usual eight-wheeled engine, follows with a detailed description, which correctly applies to the drawing he gives—but throws no light on the bogies—and ends by saying: "It was set to work in December, 1812 [*sic* November, 1814], upon the railway leading from Mr. Lambton's collieries to the River Wear."

N. Wood (1838 edition), in a chapter on "Chapman's Engine," in which he refers only to the chain system, says: "Mr. Chapman had one of his engines tried upon the Heaton railroad, but it was soon abandoned"; whilst when dealing with Losh and Stephenson's patent "steam springs" engine, he mentions: "The weight of the engine forming one great obstacle where the rails were weak, . . . Mr. Chapman in his patent for the application of a chain described a plan of placing the weight of the engine upon two frames supported by six or eight wheels; and the Wylam engines, being heavier than the rails would bear, were placed upon eight wheels."

Lecount (1839), in his paragraph on Chapman—although there is some confusion in the middle of it—clearly refers to two distinct locomotives; one being equipped with the chain system and tried at Heaton Colliery, and the other with its wheels driven by spur gear. The text is not definite as to whether the former had eight wheels, nor where the latter was tried; but says of the latter, "the wheels were worked by spur gear and not by the chain."

O. D. Hedley (1858) gives technical (?) descriptions, which if read with sufficient care will be found to contain some significant pointers. He gives the usual eight-wheeled engine view—right side, as in Wood's illustration—but in the first sentence of his description of this drawing he says: "In the diagram of the engine P represents a pinion wheel [*i.e.*, the upper central pinion taking the drive from the connecting-rods] which does not appear in the experimental carriage [*i.e.*, the adhesion-test man-power vehicle of W. Hedley]. Whether or not it was placed here in the first instance as a means of obtaining power, or from the state of the railway, I do not know." Further on he adds that when the alteration to four wheels was carried out, "five teeth wheels were used in place of three, which I think was to enable the engines to go round the curves." It is clear from the foregoing that whatever O. D. Hedley's knowledge was, he was decidedly hazy regarding the mechanical details and purposes of the drawing around which he built his claims for W. Hedley.

Later in his book he gives a copy of a letter dated December 10th, 1836, from W. Hedley to Dr. Lardner, in which the former sets out various claims to being "the individual who established the principle of locomotion by the friction or adhesion of the wheels upon the rails"; in which, after claiming the return-tube furnace, he adds: "The engine was placed upon four wheels, and went well," and although he makes reference to the bad state of the Wylam track, no mention occurs of eight-wheeled engines. Only in a footnote (by O. D. Hedley) to the letter is there mention of the introduction and subsequent disuse of eight-wheelers, and so W. Hedley, when stating his claims, said nothing about such engines. If he had originated an eight-wheeled non-bogie locomotive it is most unlikely he would have omitted to claim the credit.

It is therefore established (1) that there was one engine of the Chapman eight-wheeler type tried on the Lambton—and Heaton (?)—line, and (2) that there were similar Chapman-Hedley engines either built as, or converted to, eight-wheelers upon the Wylam line. From this it issues that the former would have been upon one or two bogies, whilst we should expect those upon the Wylam line—in view of Hedley's interest in abstaining from using Chapman's patent—to have been nominally without, but probably having some embryo provision or allowance for swivelling.

As both N. Wood and Partington obtained their respective "master" drawings from the Wylam line—Wood calls his "a drawing of one of the engines at present used on the Wylam Colliery Railroad," and Partington calls his "employed at Wylam Colliery, for which we are indebted to Mr. Hedley"—it is clear they represent the Wylam engines, and the fact that the "bogie" arrangements are shown so indefinitely is probably because Hedley did not want to enlarge on the Chapman influence in the design; but which, nevertheless, was still sufficiently apparent to contemporary engineers to cause some of them to attribute the whole design to Chapman.

P. C. DEWHURST.

Montevideo, August, 1941.

PEACE AIMS

SIR,—From April to July, 1935, you published lengthy correspondence on monetary reform, to which I made several contributions. Since then I have paid a number of visits to the Soviet Union, and have in consequence rather lost my former enthusiasm for schemes to bolster up the capitalist system. Nevertheless, the present correspondence under the heading of "Peace Aims" rouses the old monetary reformer in me, and I should like to make the following comments on "Orthodocian's" letter in your current issue.

(1) "Orthodocian" implies that under the prevailing system the amount of purchasing power increases *pro rata* with increases in assets.

But even if this is true, it does not follow that such purchasing power is diffused throughout the community sufficiently to allow mass consumption to balance mass production. If purchasing power is diverted from the channels of exchange into the channels of investment, the result may be equivalent to deflation for the time being; and deflation, as Mr. Reginald McKenna long ago remarked, can only lead to the strangulation of business and widespread unemployment. That such a diversion of purchasing power takes place is well known. In the words of an American economist, "The higher income classes save mechanically. . . . All present wants, even at enormously wasteful and conspicuous standards of expenditure, are satisfied without present spending of more than a fraction of present income. All they can do is to turn the huge unexpended balance into the loan and investment fund."

Money invested is no doubt money spent in the long run. But (as Sismondi remarked over a hundred years ago) we must desist from the habit of abstracting from time and space. In the long run we are all dead. The point to concentrate on is the rate of flow of money from consumer back to consumer. When a large part of the circulating medium is retained among a relatively small part of the community for investment purposes (to accumulate fresh interest for the financial class and so causing still further maldistribution of purchasing power) it cannot at the same time be fulfilling its proper function of mediating widespread consumption of goods among the masses. Moreover, the deficiency in distributed purchasing power thus caused is aggravated by the fact that when money derived from production of consumer goods is invested in means still further to increase productive capacity it is used twice in succession to bring goods to market. There is thus an increase in consumption goods unaccompanied by a corresponding distribution of purchasing power to buy them. Mass consumption does not keep step with mass production. One outcome of this is increased concentration on advertisement and high-pressure salesmanship, which can make people forsake one commodity for another, but cannot increase the purchasing power of the community as a whole.

(2) Your correspondent also implies that production made possible by bank loans enriches the community, giving a "new building" as an example. But it is notorious that security for the banker, not the enriching of the community, is the guiding principle of banking policy. Enterprises which produce rubbish, such as quack medicines, or consume raw materials, fuel, and millions of working days on unnecessary advertisement designed to make people buy what they do not need, frequently get loans which are denied to those who seek to enrich the community but cannot offer equal security. Enterprises which deliberately restrict production, and even destroy goods produced, to keep up prices and profits, are also examples of "illth" resulting from bank loans. There is, of course, no point in blaming the banker for this. It is the system which is at fault.

HUGH P. VOWLES.

Stonehouse, September 23rd.

SIR,—I have been interested in the letters by Mr. I. V. Robinson and others regarding the creation of credit. It seems to me that all your correspondents rather miss the point with regard to post-war purchasing capacity. The creation of credit and other devices is simply a means of cutting up the post-war cake, but the size of that cake will not depend upon internal credit facilities, but upon our external purchasing power and that, in its turn, will depend upon our capacity to persuade other nations to purchase our goods. Mr. Robinson apparently appreciates that his credit scheme may be dependent upon our external purchasing power but he dismisses this problem rather airily by the suggestion that other nations will fall into line with whatever value we place upon the pound sterling. In order to provide the raw materials that would be required for any extended internal purchasing power, based upon the creation of credit against productive capacity, we have to exchange goods, not pounds, for the raw materials required. If we were an entirely self-contained community I quite understand that it might be possible (that is not to say that I agree it would be desirable) to create credit against production, but unless we could persuade a self-dependent block of nations to enter into the scheme, it appears to me that an increased creation of credit would simply hasten steps on that downward path which leads ultimately to national bankruptcy.

A. SHEPPARD.

King's Lynn, September 29th.

MACHINE TOOL CAPACITY CLEARING HOUSES

SIR,—Although some of your readers may already have been in contact with the Machine Tool Capacity Clearing Centres of the Production Executive Regional Boards, there may be others who have not learned of the help these clearing centres can be to works managers, production managers, and other executives when up against the problem of finding spare capacity or of finding work for temporarily idle machines.

In the London and South-Eastern Region (London, Kent, Sussex, and Surrey) we have ten clearing centres. They are in effect capacity exchanges, designed to do for manufacturing capacity what the employment exchanges do for labour. Each is in charge of a technical officer of the Board.

The clearing centres have a comprehensive register of the firms in their district and of their machine tool facilities. They keep in touch with firms who have spare capacity for which they want work, even where the spare capacity may be available for short periods only. "Spare capacity" fluctuates from day to day, but the aim is to waste none of it that can be used to the national advantage. All this information is kept at the clearing centres in a simple but systematic way, so that when a firm asks for assistance it can be put into touch with what it wants with a minimum of formality and delay. Needless to say, the business of fixing prices, deliveries, &c., is left to the two parties who have been introduced.

Altogether, the clearing centres of the London and South-Eastern Regional Board effected over 2000 successful introductions between January and July. In about three-quarters of these, the value of the job was given, and they totalled over a million pounds. But I must stress that this is entirely out of ratio with the unassessed value—a million does not sound a lot when the nation is spending many times that amount every day. The only true monetary value that could be put on these introductions is the total value of the contracts that would have been held up without them.

The clearing centres aim at fostering a friendly spirit amongst the firms in their districts. The technical officer in charge of the clearing centre gets on close relations with the factory managers in his district, and the danger of factory managers feeling they are going to run into a fog-bound maze of red-tape-bestrewn blind alleys is eliminated. There is then a much better chance of factory managers getting together amongst themselves, and seriously co-operating with each other—which is just the object of the whole clearing centre scheme. And there is far less chance of any capacity being overlooked.

May I urge all concerned to get into touch with their local clearing centre at once? There is nothing to be lost, since the service is free. Like all exchanges, the more people use them, the more efficiently they run. The greater the number of new users, the better service everyone gets, with a widening of the scope of possible benefit to all.

The addresses of the clearing centres in the London Region are as follows:—

		Telephone.
Acton	60A, High Street, Acton W.3	Acorn 5071
Croydon ...	Equitable House, George Street, Croydon	Croydon 5189
Edmonton ...	198, Fore Street, Edmonton	Tottenham 5481
Eltham ...	20, Court Road, Eltham, S.E.9	Eltham 5588
Harrow ...	15, College Road, Harrow	Harrow 2602
Ilford	Rooms 15 and 23, Cranbrook House, Cranbrook Road, Ilford, Essex	Ilford 0038
Westminster	Room 429, 4th Floor, Romney House, Marsham Street, S.W.1.	Franklin 2211 Ext. 2680 & 2673
Guildford ...	32, High Street, Guildford	
Rochester ...	Moat House, The Esplanade, Rochester	Strood 7276
Sussex... ...	About to be opened	

The scheme is rapidly being extended to other regions, and provincial inquirers can get details from their respective Regional Boards.

SIMON MARKS,
Deputy Chairman, London and South-Eastern Regional Board.

London, W.C.2, September 25th.

Sixty Years Ago

THE SEVERN TUNNEL

IN our issue of September 30th, 1881, we reported that the two main headings of the Severn tunnel had been united on the night of Monday, September 26th. Considerable difficulties had been encountered in the execution of the work, mainly by the flooding of the headings. Water from springs in the surrounding hills on the Monmouthshire side had driven in a large mass of the Pennant sandstone, through which the tunnel passed, and had filled the workings on that side. Water had also entered the Gloucestershire side. As a consequence of the flooding work on the tunnel was stopped in the autumn of 1879, although only 120 yards of the heading remained to be driven. Powerful pumping machinery was then installed by the contractor for the completion of the tunnel, Mr. A. T. Walker, and after several months' delay work was resumed. When the headings met they were found to show a divergence of only 3in. The headings were 7ft. high and 7ft. wide. That on the Monmouthshire side was driven a distance of 11,000ft. from the bottom of a shaft 180ft. deep. The length of the Gloucestershire heading was 1680ft. The work remaining to be done, we said, included the widening of the headings to 30ft. and increasing the height to a proportional amount.

THE "CASTALIA"

In the same issue we announced the forthcoming sale of the cross-Channel paddle steamer "Castalia," a twin-hull vessel similar to the better-known "Calais-Douvre." The "Castalia," of 1553 tons, was designed by Captain Dicey and was built by the Thames Ironworks and Shipbuilding Company, her engines, of 250 nominal horsepower, being supplied by J. and A. Blyth and her four boilers by Maudslay, Sons and Co. She was provided with two first-class saloons on deck, a second-class saloon, a ladies' saloon, private cabins and "every requisite accommodation for a first-class passenger trade." During the short time she was on the Channel station, it was stated, she proved herself a remarkably comfortable and steady vessel.

The Use and Misuse of Science in Government*

By A. V. HILL

In the *Manchester Guardian* recently appeared a little poem, entitled "Die-hards," referring to the present meeting of the British Association. As a description of our President, Sir Richard Gregory, it could hardly be bettered, for "die-hard" is just what he is—in his determination that science, the friendly tolerant spirit of science, the liberal internationalism of science, the power provided by science, shall be applied humanely and whole-heartedly in world affairs. Having got this idea firmly fixed in his head, shall we say between seventy and eighty years ago, and being more anxious now than ever to apply it, he can justly claim to be called a die-hard—and die-hards we all need to be in these days, if we are to preserve civilisation. The British Association by deciding, "circumstances permitting," to hold its meeting this September, shows that it has the same die-hard spirit as its President; and since civilisation itself is at stake, civilisation is what we are here to discuss, and how science can help in maintaining and improving it.

We shall hear at these meetings of the many ways in which science impinges on world affairs. We must not forget, however, that one of the chief methods of science is criticism; and the most important objects of criticism are one's own ideas. Without criticism accurate observation and rigorous deduction may easily be displaced, either by imaginative or sentimental speculation or by fraud. This, unfortunately, is very likely to occur when science gets mixed up with politics—politics being defined politely as the art and science of government. If you find that what I say is largely critical, do not think that I have any hesitation about applying science in government and human affairs, or that I underrate what can be achieved. A good tool, however, must be properly used; otherwise the tool will be damaged, its user perhaps injured, and the job will remain undone. The tool in this case is so good, the hopes for its proper application so high, that on an occasion like this it is well to consider frankly the dangers and difficulties in its use. All new methods and discoveries, alas, are quickly followed by two things—by half-baked attempts to apply them to everything under the sun and by unscrupulous exploitation for selfish purposes. The deliberate application of science in government is a new method; it has never been properly or whole-heartedly tried. If it is to have a decent chance of success now, it must be saved from the start from sloppy thinking, careless handling, or unscrupulous use.

Just before the war and a few months before he died, Wilfrid Trotter, surgeon, neurologist, teacher, and acute observer of mankind, lectured at St. Mary's Hospital on "Has the Intellect a Function?" He started out, as he dryly said, from the innocent and laudable idea that people should be encouraged to think for themselves. By so doing they might be enabled to "contemplate usefully our current experience, and to develop opinions on social, political, and national situations without being entirely directed by custom and by prejudice." He warned his hearers, however, not to imagine that the practice of the scientific method alone would enlarge the mind to deal with human affairs. "Nothing is more flatly contradicted by experience than the belief that a man, distinguished in one or even in several departments of science, is more likely to think sensibly about ordinary affairs than anyone else.

For thousands of years, Trotter recalled, "the ablest men of every age have been fidgeting with the mechanism of the intellect in the hope of helping mankind to think and therefore behave reasonably." If our social system is to be saved from increasing confusion, he reflected, some radical corrective is necessary to our thinking; due allowance must be made for our emotions and prejudices. "We must get rid of the disastrous belief that there is any activity of the mind corresponding with the conception of pure reason. . . . All processes of reasoning, however abstract, are participated in and influenced by feeling. What we can do is to suspect the grosser cases of the effect of feeling and to make an appropriate correction."

I have quoted Trotter's words at such length because as soon as science is involved in government, *i.e.*, with practical affairs in which strong emotions and irreconcilable interests occur, there is grave danger that it may give up its normal attempt at objectivity and resign itself to advocacy; it may cease to take account of all the facts and—what is all too easy—may select only those which fit some conclusion arrived at already by interest or feeling. "The intellect," as Trotter said, "has shown itself to be, after all, no more than a human organ, with preferences and caprices like the stomach and kidney." Even in the laboratory it is notoriously difficult to pay the same regard to facts one does not want as to those one does; how much more difficult in the hospital, in the market place, and, most of all, in public affairs where emotions are strong, vested interests are involved, and political propaganda and prejudices are rife? We should not be here to-day unless we felt that science had an important place in government. But if science is to play its proper part, it must be consciously aware of the dangers which beset it, it must deliberately choose objectivity instead of advocacy, it must condition its followers to the conviction that scientific integrity and a clear scientific conscience are much better bedfellows for a scientific man than political honours or public fame.

Few things are harder in public affairs than to maintain that attitude consistently. Compromise is usually and admittedly necessary in matters of feeling, interest, or policy, and in the ordinary affairs of life; without compromise the machinery of government would not run. It is fatal, however, to compromise with scientific facts or to select only those facts which agree with the conclusions arrived at by other kinds of compromise. Unless, indeed, the integrity of science is sternly maintained, damage rather than advantage will result from its introduction into government. A gay and light-hearted application of half-digested science to public affairs, or the use of scientific prestige to push political or social stunts, will get us nowhere. Science is a fine tool, but every good workman knows that the finer the tool, the greater must be the skill and discretion of its user.

Some years ago in a Huxley Memorial Lecture I quoted a statement by Robert Hooke, dated 1663, describing what he called the business and design of the Royal Society, namely:—

> "To improve the knowledge of naturall things, and all useful Arts, Manufactures, Mechanick practises, Engynes and Inventions by Experiments—(not meddling with Divinity, Metaphysics, Moralls, Politicks, Grammar, Rhetorick or Logick)."

This statement I dared to adopt as a text for some further reflections. Several times since then I have been accused by scientific colleagues of inconsistency; indeed, they point out now that as a Member of Parliament I cannot avoid meddling with "Moralls, Politicks and Rhetorick"—though some of them perhaps would not accuse M.P.s of meddling overmuch with "Logick." Be that as it may, I am quite unrepentant and will repeat what I said then:—

"Not meddling with morals or politics. . . . I speak not with contempt of these—indeed, the scorn with which some superior people talk of such necessities of social existence as morals and politics seems to me intolerably childish and stupid. The best intellects and characters, not the worst, are wanted for the moral teachers and political governors of mankind; but science should remain aloof and detached, not from any sense of superiority, not from any indifference to the common welfare, but as a condition of complete intellectual honesty. . . . If science . . . becomes tied to emotion, to propaganda, to advertisement, to particular social or economic theories, it will cease altogether to have its general appeal, and its political immunity will be lost. If science is to continue to make progress, if it is to lead to the advancement and not to the destruction of human institutions, it must insist on keeping its traditional position of independence, it must refuse to meddle with or to be dominated by divinity, morals, politics, or rhetoric."

By this I did not mean that the results of science should not be applied to government—that, indeed, would be inconsistent—or that scientific men should not take part in government, that science should not be financed by government, or that the direction of research should not be pointed by public needs; and I certainly did not wish to imply that scientific men, as citizens, should not be expected to hold political views. But I did mean that the sole object of science is to arrive at the facts, that no consideration of religion, morals, or politics should be allowed to deflect it by one hair's breadth from its integrity, that the repute of science itself (which is the collective property of all scientific men) must not be exploited for selfish or sectional purposes, and that neither authority nor vested interest, emotion, precedent, or custom, greatly as they may influence us as men, should be allowed to bias our scientific observations or the conclusions we draw from them.

It may be asked, Isn't this all very obvious? Why go on labouring it? There was a time—not so long ago—when freedom and peace and reasonably decent standards of national and international behaviour seemed obvious, too. Had we not been blind to the fact that these could be maintained only by continual watchfulness, effort, and sacrifice, the state of the world to-day might not be so deplorable. There is grave danger that by a gradual process, too slow to give any of us a sudden jolt, the integrity of science may be undermined. We have only to look at Germany and Italy to see how. But, some people will say, these things never happen to us. That kind of unteachable complacency has dogged our national footsteps these many years. No good cause, alas, is permanently won—even in England! We can avoid disaster of this kind, not by trusting to feeling rather than reason, not by denying evident facts because we do not like them, but only by incessant watchfulness and an obstinate determination to maintain our scientific independence and integrity.

Warmly, therefore, as one may welcome a conference of this kind, anxious as one may be to see all the resources of science, its results, its methods, and its habits of mind used in the service of the State, it is necessary to urge—and to go on urging—that unless the independence and objectivity of science are upheld more harm than good may result. It is so easy, for sentimental reasons, to tumble into sloppy thinking. It is so easy to follow the fashion and find in science a universal cure-all. It is so easy to acquire cheap fame by using specious scientific arguments to bolster up some popular or partisan belief. Not only, thereby, is damage done to the State, but the high repute of science itself, built up slowly over generations by the integrity of its followers, is lowered.

Not only, however, by allowing one's thinking apparatus to be tied to one's interests or emotions, but in other ways may science in government be misused. The primary difficulty is that the bureaucratic method, with its authority, its routine, its discouragement of initiative, its lack of freedom and criticism, its secrecy, provides the antithesis of the environment in which good scientific work is usually done.

I know well enough that planning and direction are necessary in government and industrial research; but somehow the spirit of freedom and initiative, of criticism, of intellectual equality between senior and junior, must be combined with them if science is not to be frustrated. This is not impossible. There are Government establishments in which the spirit is 100 per cent. right; unfortunately, there are others in which it is miserably wrong. The spirit is likely to be better where contact with outside science is the rule, where publication is normally permitted, where criticism and discussion are possible, where something more like the atmosphere of a university exists, and where a guiding and inspiring influence can be exercised, sometimes behind the scenes, by advisory bodies of experienced independent

* British Association, London, September 26th to 28th, 1941, "Science and World Order": 1st Session, "Science in Government."

scientists. Such conditions exist in ordinary times to a greater degree than elsewhere in the laboratories and establishments of the three Research Councils, and of the Research Associations which are partly under Government and partly under Industry. The Civil Defence Research Committee, working for the Ministry of Home Security, provides an excellent example in wartime. Let us specially consider, since they are vitally concerned with the utilisation of science, the Service and Supply Departments.

In the research establishments of the Ministry of Supply the Scientific Advisory Council and its numerous committees, chiefly composed of independent scientists (including engineers), exert a considerable and beneficial influence. By personal visits and contacts, by holding meetings at the stations themselves, and in a variety of ways, members of the committees can help to keep the workers in these establishments in contact with outside ideas and criticism, and to see that unnecessary routine and formality do not hinder their efforts or thwart their initiative. Had this organisation existed before 1940, we should have been more ready for a scientific war. Fortunately, the Chemical Defence Board and a few similar bodies had continued to get the assistance of independent scientists ever since 1918. One may hope that neither false economy nor pacifism will bring such co-operation to a premature end once more.

The Admiralty, on the other hand, with its traditional devotion to secrecy, has always resisted any suggestion that an advisory council, containing independent scientists, should be set up to take an interest in its research. Much first-class work, of course, has been, and is being, done in Admiralty establishments, and the nation is deeply in their debt; even that, however, would have been helped and quickened by an advisory organisation similar to that of the Ministry of Supply; and for the rest, one suspects that secrecy—often admittedly essential—is sometimes extended (perhaps unconsciously, for people are seldom aware of their real motives) to hold criticism at arm's length. Fortunately, a beginning has at last been made by the appointment this year of a small advisory panel containing two independent scientists—compared with about fifty helping the Ministry of Supply!

In the Air Ministry, and now in the Ministry of Aircraft Production, the conditions are intermediate. Radiolocation, the most important scientific development of the war, started with an independent scientific committee working with the Director of Scientific Research as far back as 1935. Scientific bodies of various kinds now advise the two Ministries, and, fortunately, Sir Henry Tizard is at last in a position to give his unique knowledge and experience unhindered to the scientific needs of air warfare. Much first-class work is done in the scientific establishments of the M.A.P., and secrecy is not such an obsession as with the Admiralty. It would be wiser, however, to stabilise the use of external scientific advice by some constitutional organisation analogous to that of the Ministry of Supply.

One general reflection of great importance may be made on science in connection with the Services. It refers to the necessity of having scientific men of high quality and initiative in close touch with actual operations. In war, urgent problems and difficulties arise, sometimes suddenly, which an experienced scientist can recognise as capable of scientific treatment, which other people cannot. In a war waged at the speed of the present one, grave damage or disaster may follow failure to tackle an operational problem or difficulty immediately; great advantage may result from anticipating it. Moreover, new devices, methods, and weapons seldom work perfectly when handed over to the troops. If their full usefulness is to be achieved they must be nursed through their teething troubles by people who understand them, and the tactics and strategy of their employment must be worked out by "users" and scientists in collaboration.

This does not imply that scientists need set themselves up as experts in strategy. It does mean, and it has meant that very serious harm indeed may be done by failure to bring science into contact with the actual user, and with operations, at all stages. It is a grave mistake to put scientists and soldiers into separate watertight compartments. The former are not just superior technicians paid to dish up the magic which the latter in their superior wisdom order. There should be continual and instant collaboration up to the highest level in the common task of applying all the resources of science and technology to frustrating the knavish tricks of the enemy and prosecuting our own initiative against him.

Perhaps I may interpolate here that although the principle that the scientist should be in direct contact with the "user," or with "operations," applies literally only to weapons and methods of war, it is, in fact, universally applicable. War happens at the moment to be the most urgent example, but throughout all the applications of science, whether to war, to government, or to industry, the same principle applies. The scientist, the specialist, should not remain for ever in his laboratory; there, no doubt, is his primary concern, and heaven forbid that scientists should become general busybodies (as for my sins and Hitler's I am forced for the present to be); but unless he looks outside his own little wood sometimes he will fail to see the wood for the trees, or to understand the relation of his task to the bigger tasks of the world. In whatever sphere of human activity his work has application, the scientist should be in touch with the "user," the "user" in touch with the scientist. So only can science in government, or science in industry, or science in human affairs, fulfil its desired *rôle*.

So much, then, for research in Service or Supply Departments. In many other departments of government, however, there is need of scientific consultation, scientific foresight, and scientific criticism. In these also, unless experienced scientific people are available to keep in touch with their everyday work, scientific problems or opportunities may never be realised as such until too late. Permanent officials with a scientific education can meet part of the need; but not all of it, for they are bound to become rusty in their offices and anyhow the people with the keenest and most original minds are not usually inclined to become officials at all. The advice of outside scientists is necessary.

Some departments act on this principle, but not all of them. Sometimes even those that profess to do so specialise rather in figureheads, seeking more to be able to answer questions in the House with a display of famous names than really to seek up-to-date scientific advice. One department, for example, when recently questioned, proudly named an adviser aged eighty-six years. It is important that every department in which science in its widest sense can find application should be accessible to independent scientific advice. It is not necessary—indeed, it would be absurd—to ask that an organisation of the magnitude of the Scientific Advisory Council of the Ministry of Supply should be set up in every department; but a panel of two or three independent advisers at least is necessary if opportunities are not to be missed. This panel should have a recognised status, and reappointments should be made to it every few years in order to ensure that the system—and the scientists—are really alive.

In this country we do not believe in bureaucracy. Our national genius has evolved a system by which the activities of officials are continually subject to the advice and help and criticism of public-spirited citizens. The wise officials appreciate this; the stupid ones do not. Let us never abandon this principle, otherwise, with our traditions, we are in for a long spell of trouble. Let us rather praise and extend it, whatever our totalitarian youth may say. One way to extend it is to insist that independent scientific advice shall be given a constitutional place, and a constitutional right to be heard, in Government Departments.

Even, however, if departments were saturated with scientific advice, it would still be necessary to ensure that the Cabinet itself should be properly served. The Scientific Advisory Committee and the Engineering Advisory Committee, both under the chairmanship of Lord Hankey, now fulfil that function here. The arrangement is new, but undoubtedly it works well. Dealing as they do with the reactions of science and technology with policy, at present particularly but not exclusively in connection with the war, the Committees cannot busy themselves with details which naturally go to departmental bodies, and most of their activities cannot in wartime be publicly described. The Chairman, as a Minister of high rank, working under the Lord President of the Council, who is the member of the War Cabinet primarily responsible for research, has access to all Ministers and Departments. A new link has thus been forged, and science at last is in contact with the centre of government.

In the United States a similar link exists. The Director of the Office of Scientific Research and Development in Washington is directly responsible to the President. Under this organisation come the National Defence Research Committee, the National Advisory Committee for Aeronautics, and the Medical Division of the National Research Council. This arrangement is quite new, and in many ways different from our own; but it is like it in the sense that in the United States, as here, science now has direct access to the centre of government. May it so continue in both countries!

I have dealt with the attitude of mind from which the problems of science in government must be approached, and with the organisation needed at departmental and Cabinet level. It remains now to deal with the scientists themselves and the problem of how to keep them alive. It is essential, if the scientific minds of the scientists in Government employment are to be saved from sterility, and their souls perhaps from damnation, that there should be as little distinction as possible between them and those in the universities, in industry, and in other independent institutions. In wartime there is little distinction; we are all in it together. What I say applies to the more normal times of peace.

Government scientific employment in general has certain characteristics:—

(1) It has security of tenure, fixed hours of work, regular promotion, and a pension.

(2) Adequate equipment is usually available, and there is not a continual struggle for funds.

(3) The object and direction of investigation are usually laid down by authority.

(4) Discussion and publication are usually limited, sometimes because of the real or alleged necessity of secrecy, often simply by tradition.

(5) Teaching duties generally do not exist, and there is often no necessity to follow the scientific literature except in a special field, with the result that interests are likely to become narrow.

(6) Attendance at meetings of learned societies, conferences and congresses, the holding of colloquia and discussion meetings, and contacts with scientists in other fields are rare.

(7) Visiting workers, particularly foreign workers, are few or absent altogether.

For such reasons, unless a man has exceptional ambition and originality, his initiative and keenness tend to be blunted. There are several ways to avoid this:—

(*a*) To ensure that directors of research, heads of laboratories, &c., are people of exceptional quality, not only in ability, originality, and experience, but also in their human relations and sympathy. Such men in such positions are rare, but they exist; their value is very great. It is essential that they should remain investigators at heart, and as far as possible in action, and not become mere bureaucrats.

(*b*) To adopt a common pension scheme, similar to that of the Federated Universities System, with the universities, with industrial laboratories, and with all institutions in which scientific work is done.

(*c*) To encourage junior and senior workers alike to interchange freely with other departments, with industrial laboratories, or with universities.

(*d*) To provide facilities for visiting workers, for colloquia and discussion meetings, and for attendance at meetings of learned societies.

(c) To adopt a system analogous to that of the reserve of officers and other ranks by which the Fighting Services prepare for times of emergency. Many of the ablest workers elsewhere would rightly value a period of service in Government laboratories, although not prepared to devote the whole of their lives to it. After their period of service, they would return to their chosen jobs in universities and other places, with occasional "refresher" periods later.

I have urged before that this system of building up a reserve of scientific officers should be adopted as soon as normal conditions return. It would be the greatest pity if the many able men who have done such excellent service in Government establishments should then lose touch permanently. Widespread support of this proposal has been evident. It has many advantages; sudden expansion in emergency would be much easier, the universities and other institutions would be kept in touch with Government scientific establishments, and *vice versâ*, those who joined the Government service would not be permanently isolated from the scientific workers outside, and the highly interesting and important work which is done in Government laboratories would be more commonly appreciated and known. By forming such a reserve, the intellectual status and the fruitfulness of Government science would inevitably be raised and the universities would be brought into closer touch with realities.

There is no need to go into details; they can be settled later. The broad principle is that in every way we need to break down barriers between universities, independent research institutions, industrial laboratories, and the scientific establishments and service of the Government. This can be done by regular interchange of personnel, by a common pension system, by providing in the Government laboratories all those facilities for discussion, for meetings, for criticism, for initiative, for collaboration—even perhaps for teaching—which are found elsewhere. We must not be deterred in this project by bureaucratic objections, by false economy, by the red-herring of secrecy, or by alleged administrative difficulties. In science also we must deliberately follow the line of our national genius, and ensure the fullest co-operation and interchange between independent science and science controlled by the State.

This plan for a reserve of officers and for frequent and regular interchange between different kinds of institutions need not be limited to science; it should be open to the Government service as a whole. Drastic changes are needed in the Civil Service. Personal ability and personal integrity, essential as they are, are not sufficient; the outlook, the methods, the organisation, the traditions of the Civil Service must be altered, and contact must be maintained with the real world and its methods outside. The war has shown, what many suspected already, that for all its devotion and its high traditions, the Civil Service has largely failed; the same might well be said of Parliament, but that is another matter. Nothing could be better for the Civil Service, for industry, for the universities, than to institute a regular interchange of personnel; to treat the universities as staff colleges to which workers from the Civil Service, or from industry, return at intervals for refreshment; to treat industry and the Civil Service as the workshops in which for a period university dons can obtain practical experience; to give to Government offices a touch with reality, and to industry a touch with national needs, by the mutual temporary interchange of some of the ablest men on either side. We are concerned here to-day primarily with science in government. Science, however, will never be given full scope until a revolution has occurred in the methods and outlook of government itself.

May I finish on a note, not of criticism but of hope? Under the old regime of *laissez faire*, which we intend that the proper use of science in government shall replace, our public health services were organised mainly on the principle of trying to cure people when they were sick, our architecture on mending the pipes when they burst after a frost, our industry on paying people a dole when they were unemployed, our national defence on getting ready when a war had begun. It is obvious, however, that scientific planning and the planning of our national resources can make many of our troubles unnecessary. By designing our houses properly the pipes need never get frozen up; by proper attention to nutrition, to public health, and physical education, sickness can be largely avoided; by deliberate planning of public works, unemployment can be greatly reduced and the standard of living raised; by adopting a period of national service, universal for men and women alike, as the highest form of democracy, we can avoid blundering unprepared again into war, and can add a new dignity to our citizenship. Scientific planning, and planning with the aid of science, are what we look forward to; planning, however, in which any new order we arrive at is fitted to our traditional freedom.

Road Activities of the L.M.S. Railway

LAST week there were demonstrated at an exhibition at Euston Station some of the wartime activities of the road motor department of the L.M.S. Railway. The war has had considerable effects upon the operation of road transport. Spare parts, for instance, are in short supply, petrol is rationed, and certain materials are either difficult to obtain or demand in their use as much economy as possible. The exhibition was intended to show how the efficiency of the L.M.S. road fleet was being maintained, despite economy in the use of materials, by adopting a variety of expedients.

FIG. 1—"MECHANICAL HORSE" WITH RUBBER SCUTTLE, GRILLE, AND WINGS

One of the more direct ways of conserving supplies is the reclamation of worn parts which in peacetime would have been scrapped. Fortunately, it was foreseen before the war that spare parts were likely to be difficult to obtain, and measures were taken to install plant and to train men for various specialised repair jobs, and to get into touch with specialist firms. Examples of the kind of work now done were on view, and included engine crankshafts of which the worn bearing journals had been built up by metal spraying and by electro-deposition; an engine camshaft the profiles of the cams of which had been built up by welding; a piston of which the skirt had been expanded by the "Koetherising" process, the ring grooves turned and new rings and gudgeon pin fitted; ball bearings with worn ball tracks reground and oversize balls fitted; an engine starter ring with broken teeth built up by welding; and several other equally interesting repairs.

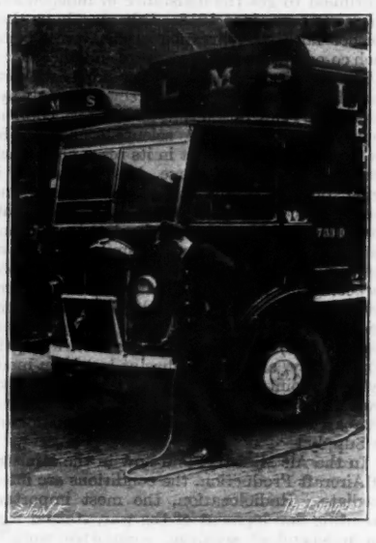


FIG. 2—FITTING FOR STARTING ENGINE ON TOWN'S GAS

The company, after extensive experience in the use of a Bramley oil cleaning plant, which had been installed at its Manchester Road

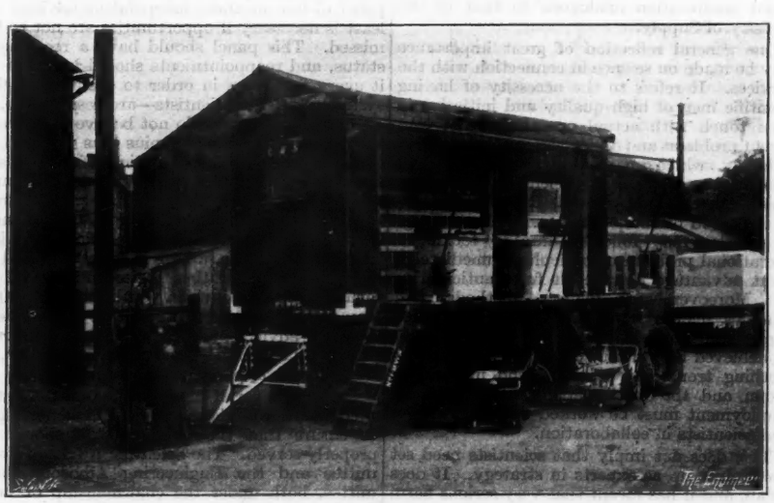


FIG. 3—MOBILE WORKSHOP

depôt, has gained such confidence in the use of treated dirty oil that no less than 70 per cent. of such oil is now recovered. The reclaimed oil, totalling some 14,000 gallons a year, has been found, according to representatives of the company, equal in quality to new oil. Examples of new oil and recovered oil were exhibited together with dirty oil and dirty oil which had been filtered, but not further treated.

Specialist attention is given to rubber motor tyres to ensure that the longest possible life is obtained from them. If, after the tread has been worn off, sufficient rubber still remains, the tread is re-grooved by appliances which have been provided in the main road motor workshops. Tyres worn beyond that stage, but otherwise sound, are remoulded by the makers or other specialist firms. Cases sometimes occur where tyres suffer local serious damage to the fabric, although elsewhere perfectly sound. Tyre manufacturers will not undertake the repair of such damage, as they feel themselves unable to guarantee its success. The railway company has therefore had men trained for the work, and plant has been installed at the Manchester Road motor depôt. An example of the kind of work undertaken was exhibited. The tyre had apparently suffered a "pressure burst." The fabric was torn for a length of 3in. or 4in. beneath the tread, which was, of course, also ruptured. We were told that the whole of the affected area is cut out and by skilled hand work new fabric is interwoven into the sound fabric of the tyre. Rubber is then vulcanised on to and around the new fabric, and the tread reinstated. Though the resulting tyre is not as reliable in use as an undamaged one, it is very certainly sufficiently so to justify the process, especially when the original damage affected a tyre almost new.

It has been the experience of the company that the "mechanical horse" type of vehicle, which has to work, and is indeed designed to work, in narrow restricted spaces, is particularly susceptible to unimportant collisions, resulting in damage to scuttle, grille, and wings. Though such damage may in no way affect the efficiency of the vehicle, it produces an unsightly appearance. Rubber corners for the scuttles and complete rubber grilles and wings are now being installed instead of steel on all vehicles sent in for repairs, and for all new vehicles, resulting in a considerable saving, not only of steel but also of labour. A mechanical horse so fitted is illustrated in Fig. 1.

The railway has made a number of experiments with fuels other than petrol and oil. Various types of gas producers have been tested and vehicles fitted with producers have been operated under service conditions. Two vehicles so equipped have run between them more than 41,000 miles. A nucleus of men has had training in the use of producer gas, so that should a change-over from petrol become necessary at any time it should be possible to effect it speedily and with little trouble. Tests have also been made with vehicles driven by town's gas stored in gas bags, some mounted on the roofs of vehicles, some on trailers. The chief difficulty here seems to be the very limited radius of operation made possible, even by a gas bag as large as can conveniently be carried. One use of town's gas, however, has proved very successful, and is popular with drivers. It is the use of gas for starting and warming up engines in the morning. The apparatus is almost ridiculously simple. A pipe is brought down from the engine induction pipe, through the scuttle to a gas carburetter or mixing valve mounted on or behind the bumper—Fig. 2. The adjustment for air-gas mixture is made at this point. A "quick-action" pipe connection permits a flexible rubber pipe from a town's gas supply main to be linked up readily to the carburetter. The engine throttle on the petrol carburetter is left closed. On swinging the engine, it starts up at once, even from dead cold, and continues to run sweetly thereafter with none of the "coughing and spitting" that occurs when petrol is the fuel in such circumstances. This system, besides being convenient, has, too, other advantages. It is well known that much cylinder wear occurs during the warming-up period of an engine, partly due to liquid petrol washing the cylinder walls free of oil, partly from acid products produced by incomplete combustion. When gas is the fuel neither of these actions can take place.

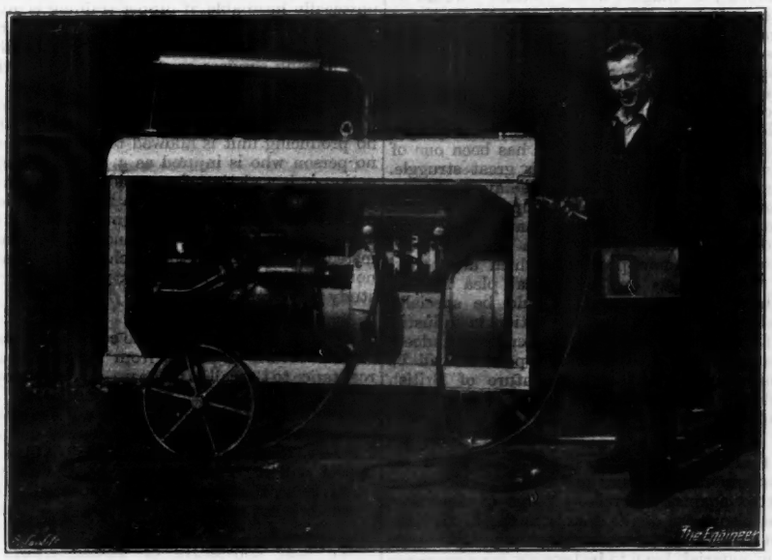
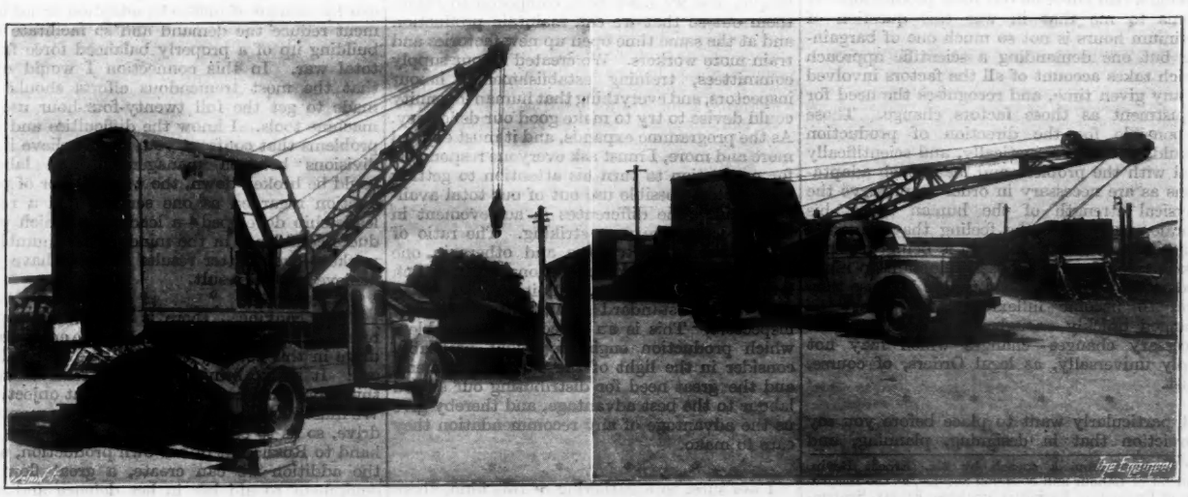


FIG. 4—MOBILE WELDING PLANT

One of the more interesting exhibits was the mobile workshop, illustrated in Fig. 3. It is not to be expected, considering the number of bombs dropped, that the *Luftwaffe* will never score a hit on one of the railway company's road motor repair or maintenance shops. This mobile workshop in such a case could be towed to a convenient spot in the affected area and is fully equipped to take over all maintenance duties and minor repairs. It would also find a use where road vehicles have to operate in areas remote from workshops. At one side, which forms the back when the vehicle is opened up for operations, there are numerous compartments for spare parts, nuts, bolts, screws, &c. In front of the shelves there is a bench equipped with a vice, an electrically driven drilling machine, and a tool grinder. At one end of the body there are a low-tension generator for battery charging and a higher voltage generator for lighting, tool driving, &c., both driven by a petrol engine mounted between them, and both having suitable switchboards. Other equipment carried in the workshops includes a petrol-driven tyre inflator, a portable oxy-acetylene welding plant, and suitable tanks for cleaning parts and for collecting used oil. Timber for body repairs is also carried and a range of jacks is available.

The mobile welding plant, illustrated in Fig. 4, is used amongst other things for the reclama-



FIGS. 5 AND 6—MOBILE CRANE READY FOR USE AND LOWERED FOR TRAVELLING

tion of worn parts. This equipment was supplied by Petbow, Ltd., of Watford, and consists of a Ford petrol engine driving an electric arc welding generator, able to operate at two outputs of 12 or 300 amperes capacity, according to the type of work involved. The change of range is affected by the use of the slotted links visible in the engraving, whilst a hand wheel and double scale above the link system permits measured regulation of the amperage.

The last engravings—Figs. 5 and 6—illustrate a type of American mobile crane, of which six are already in service on the L.M.S. and twenty-five more are shortly to become available. On a more or less standard "International" chassis there is mounted a 4½-ton crane of "Bay City" manufacture. A strong beam at the back of the lorry has telescopic pieces, which when drawn out and packed up by blocks and wedges, as shown in the engraving, relieve the springs and tyres of load. The crane is capable of handling 4½-ton loads at 10ft. radius, and smaller loads at greater radius in proportion. For travelling on the road the jib is brought round over the cab and lowered as far as possible on to suitable rests. By the removal of a pin and its replacement in a different socket, the outer part of the jib beyond the centre is further lowered to bring its head below the level of the roof of the cab. The crane hook is attached to a hook on the bumper. The crane then has the appearance as in Fig. 6. Vehicles of this type have proved very valuable around docks and goods depôts.

Personnel and War Production*

I was very interested to note that you have adopted as one of your principles that, as a scientific organisation, hours and conditions of labour were no concern of yours, but that the training and the use to be made of labour were matters to which you could properly devote your attention. In so far as the payment of wages is concerned, it is no doubt a wise decision, but I should like to have seen more attention paid by the production engineering organisations to the working out and application of an optimum labour effort. In my view, sufficient attention has not been paid to this subject, neither has there been due consideration of the fact that workers have had to carry on through two "black-out" winters with long hours on intense production. What has been proved, however, is that serious difficulties have been caused in the world of production during this past year by irregular hours, some of them necessarily due to the circumstances of the moment, but others enforced and operated without regard to the most precious and valuable of all machines—the human. I have done my best to get industry to pay more attention to this matter, for I was convinced that the long hours that were expected of the workers were having a bad effect on our total production. It seems to me that in war this question of optimum hours is not so much one of bargaining but one demanding a scientific approach which takes account of all the factors involved at any given time, and recognises the need for adjustment as those factors change. Those responsible for the direction of production should quickly, energetically, and scientifically deal with the problem and make such adaptations as are necessary in order to preserve the physical strength of the human being, his morale, and create the feeling that the well-being of the industrial army is being properly taken care of. I have been reluctant to make Orders on this question of hours because they tend to become inflexible, and cannot be changed quickly enough in wartime to meet necessary changes—changes which may not apply universally, as legal Orders, of course, must.

* * * *

I particularly want to place before you my conviction that in designing, planning, and working out the proper utilisation of our productive units there is an imperative necessity for much closer collaboration between the personnel manager and the rest of the executive, including the production engineer. The functions are equally important; the best of plans can be totally upset and much effort vitiated if the important human factor is not adequately considered and measured as a part of the general plan of production. In fact, there should be constant collaboration, owing to the changes that war produces.

* * * *

In the lay-out of this war effort there was not sufficient attention paid to the personnel problem. It took us a long time to get industry as a whole to appreciate the need for proper canteens, to imagine what "blitzes" would be like, or to have regard to the very severe nerve strain that would follow air attacks. I emphasise this now because, although we have had a respite, we shall have to face it again, and the longer the war goes on the more necessary it becomes to pay greater regard to this personnel side of industry. The absence of a proper understanding of the problem has been one of our greatest handicaps in this great struggle. Remember, thousands of people have had to be moved, their homes broken up, and billeted sometimes under conditions that were not too good. All these factors have a bearing on the inevitable human problems which are bound to arise; hence my additional plea for the personnel manager, who should be specially trained, to have an equal position in industry with other members of the executive. Indeed, I am sure that our post-war position will be materially helped and the future of British industry enhanced by a full appreciation of this important fact.

* * * *

It is well to remember in this mechanised war that our factories and productive capacity are pitted against not merely those of Germany, but also those of the countries the Nazis have over-run. We have a smaller population, our raw materials have to be brought from overseas, and, in addition, the enemy had many years' start. Therefore, if this deficiency on our side is to be made good and parity reached, spasmodic effort is not enough. It may serve as a momentary stimulus, but its effect is not usually lasting. The factors that will count are the timing, flow of materials, components, and the sustaining of effort over a long period with a continuously increasing rhythm. Nothing, I suggest, is so irritating to the workpeople as to be screwed up to a great pitch and then have a period of reaction and slack work and idling. A study of the curve of production over a period of months reveals that the final result achieved by spasmodic effort is not so good as that resulting from well-organised and sustained effort.

* * * *

It is sometimes not appreciated that we started this war with a dearth of really skilled people, and we have been compelled to ration them out so that we can maintain production and at the same time open up new factories and train more workers. We created labour supply committees, training establishments, labour inspectors, and everything that human ingenuity could devise to try to make good our deficiency. As the programme expands, and it must expand more and more, I must ask everyone responsible for production to turn his attention to getting the greatest possible use out of our total available skill. The differences in achievement in this direction are very striking. The ratio of skilled people to trainees and others in one works doing the same operation may be much larger than at another, and it is essential to establish a standard that will guide our inspectors. This is an aspect of our problem which production engineers might profitably consider in the light of the war development, and the great need for distributing our skilled labour to the best advantage, and thereby give us the advantage of any recommendation they care to make.

* * * *

I am sure, to a gathering of this kind, there is no need for me to emphasise the imperative necessity for more training. At this point I would like to say how much it has been borne upon me since I have had to deal with this man-power problem what a great mistake the State made in maintaining such a low school-leaving age for the last twenty years. How valuable it would have been to the State now if those children had been kept at school and under the control of the educational institutions of the country for another couple of years, and a portion of that period devoted to some form of training in order at least to give a basic knowledge of production, not merely in industry, but in agriculture.

* * * *

We have shown to the world in this war that there is virtually no such thing as an unemployable person, unless really mentally and physically incapable, if proper training is given to him and opportunity for employment afterwards. Hence the importance of the medical and nursing services as part of the production organisation, and this should be linked up with treatment outside and a great national rehabilitation service. This will see to it that no producing unit is allowed to be wasted and no person who is injured as a result of enemy action or is a victim of an accident in our great industrial arena is left with a hopeless outlook for the rest of his life. It may lead to the necessity of adapting machines to the man, instead of the man to the machines, but that is not difficult, and I would ask you specially to study this problem.

* * * *

One gets a little tired of the constant demand for the return of people from the Army, and resistance to the call to make up units to a proper fighting strength. If we listened to all the demands we would never have an Army and certainly it would never be properly trained. I assert, having regard to the task which we expect will have to be performed before this war is over, that the numbers allocated to the Services is not too large.

* * * *

We hear constantly of wasted efforts in industry. To what extent there is truth in it, it is impossible accurately to say, but the demand made in the productive field for man-power is just colossal. It must be remembered that when working in buildings and factories your man-power is static; you do not get a drain away continuously to provide drafts to make up wastage as you have in the Services. In other words, you do not give six months' training and then draft your people out to the Middle East or some other theatre of war, and then have to train another lot. Industry has a better chance of progressive improvement in the skill and further simplification of operations in order to make up any deficiency. Therefore I would urge that everyone responsible for production in the country should endeavour, first, to foster the co-operative spirit in the works, and, secondly, to make the fullest possible use of all available labour, and to consider, having regard to the claims made upon us, how far you can by change of methods, adaption or adjustment reduce the demand and so facilitate the building up of a properly balanced force for a total war. In this connection I would urge that the most tremendous efforts should be made to get the full twenty-four-hour use of machine tools. I know the difficulties and the problems that confront you, but I believe if all divisions between management and labour could be broken down, the whole factor of production regarded as one service, and a right leadership developed—a leadership which produces confidence in the minds of the humblest worker—even better results than we have yet achieved would result.

* * * *

I am convinced there is a great untapped reserve of managerial and productive energy and drive in this country that must now be called out. It is like bringing up your reserves and this drive must be directed to a great objective. We must sustain at least a six to twelve months' drive, so as to enable us during that period to hand to Russia out of our own production, and the addition we can create, a great flow of equipment to aid her in her defence and our mutual final victory.

* Excerpts from a speech by Mr. Ernest Bevin, Minister of Labour and National Service, at the Institution of Production Engineers luncheon, Friday, September 26th.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Steel in South America

According to the *Foreign Commerce Weekly*, published by the United States Department of Commerce, the imports of steel sheets, tinplates, tubes and wire into Argentina this year totalled 9755 short tons, compared with 18,895 in June, 1940. Reference is also made to the new plant which is to be erected in Brazil at a cost of 45,000,000 dollars, partly financed by a loan of 20,000,000 dollars by the Export-Import Bank of the United States. The plant is to be situated at Velta Redonda, Rio de Janeiro State, and will be operated by the Siderurgica Nacional S.A. Operations have been commenced on the site. At present Brazil has two steel plants, one at Siderurgica a Sabara and one at Monlevade. The former has in operation two blast-furnaces with an annual productive capacity of 26,000 m.t., three basic open-hearth furnaces with a total capacity of 36,000 tons of steel ingots per annum and one rolling mill. The output of the Sabara plant is estimated to be about 36,000 tons of round, flat, angle and square bars with a minimum section of 3in. The Monlevade plant consists of two 85-ton blast-furnaces with an annual pig iron capacity of 50,000 tons, two 35-ton open-hearth furnaces with an annual steel output of 55,000 tons, one 38in. blooming mill, two continuous billet heating furnaces, complete rolling mill for rods and wire, and one wire mill of 30,000-tons capacity per annum, which produces plain, galvanised and barbed wire. It is intended to expand the Monlevade plant and the company has placed orders in the United States for two 85-ton blast-furnaces and two 35-ton open-hearth furnaces with a total capacity of 50,000 tons of pig iron and 55,000 tons of steel. It is also intended to place orders for one complete rolling mill with electrical equipment, including a heating furnace, transfer tablets, cooling beds and shears. The proposed rolling mill is expected to roll rails for 40 lb. to 100 lb. per yard and sections from 3in. to 15in. It is anticipated that two additional open-hearth and blast-furnaces will be ordered. When completed the plant should produce about 150,000 tons of steel products annually.

The Pig Iron Market

Whilst the position of the pig iron industry in Great Britain does not greatly change from week to week, there are minor movements which affect individual consumers. Conditions vary slightly between the different districts. On the North-East Coast production is pressed to the utmost, but little foundry iron is being manufactured as nearly the whole production is devoted to basic iron for the steel works. This, however, does not mean that the foundries go short, since full supplies of Midland foundry iron are available to the North-East Coast consumers. The official quotations for Midland iron are unaltered, No. 3 being quoted at £6 8s. delivered consumers' works, less 5s. per ton loyalty rebate. Midland iron for Scottish consumers, however, is fixed at 1s. 3d. less than for Cleveland iron, of which there is little obtainable. Supplies of high-phosphoric pig iron are adequate to meet all classes, and many of the Midland blast-furnaces have accumulated reserve stocks. There is some complaint, however, on the operation of the Lease-Lend arrangement with the United States. The point is that cast iron hollowware is to be treated exactly in the same way as steel hollowware. The argument is that with adequate supplies of high-phosphoric pig iron there is a further restriction of the consumption of this description, which has already suffered from the poor consumption of the light castings industry. It is also pointed out that this class of iron has not been imported from the United States, where very little, if any, high-phosphoric pig iron is produced. Although it is said that the hematite position is slightly easier, great care is taken that any licences issued are for essential work, for which no other class of iron is suitable. It is anticipated that the stringency in this department will last for some time. All urgent requirements of hematite and low-phosphoric iron are being met, and while consumers are naturally concerned as to the future, there seems little doubt that supplies will be sufficient for essential needs.

The Midlands and South Wales

Taking the whole range of Midland steel products, the volume of business coming forward is less than in the early months of the year. Practically the whole of the production, however, is on Government account and the works are heavily booked forward on priority orders. The demand for light structural sections appears to have revived recently and considerable tonnages are passing to the consuming industries. All the re-rolling works are busy, although the demand for small steel bars is less active than even a month ago. There is an insistent demand for billets and sheet bars, and although most of the works have managed to build up reserves during the summer, the home production has to be maintained at a high rate to keep a balance. The position, however, does not cause concern, although the restriction on the imports from the United States will naturally be felt during the coming winter. The demand for plates does not greatly relax. Large quantities continue to be absorbed by the shipyards and the tank makers also have plenty of orders in hand and provide a big outlet. The decline in new business for sheets appears to have ceased and there are indications that the demand for this product will expand. Lately there has been a revival in the request for special sheets. The sheet works are well employed almost entirely upon Government orders. Business in alloy and special steels continues to increase and is particularly active in strip and sheets, which are taken up in comparatively big quantities by the aircraft industry. There has been a strong request for colliery maintenance material in the past few weeks, but there seems little doubt that the collieries will receive their full supplies. In a number of cases collieries have placed orders for their requirements over the fourth quarter of the year. Active conditions continue to rule in the South Wales steel industry, although Government restriction on the export of tinplates is sharply felt in this district. The demand for heavy finished steel is less strong than it was and some of the works could do with more orders for heavy joists and sections. The sheet trade is fairly busy, but there is a tendency for new business to be insufficient to balance completed contracts.

The North-East Coast and Yorkshire

In spite of changes brought about by the war, the Steel Control and abnormal conditions generally, the North-East Coast claims to have maintained its position as the principal producing district in the country. For some weeks there has been a tendency, however, for a slackening in the volume of business coming forward and it is suggested that the demand is less than it was a year ago. All the steel works, however, have well-filled order books and most of them can see their way to practically capacity working for many weeks to come. The noticeable falling-off which occurred in the summer in business in heavy joists and sections is still apparent, but there are indications that activity is reviving in this branch of the industry. The latest movement in the demand has been for some slackening in requirements of small bars and sections and in some cases re-rolling works have become somewhat short of work, new business having perceptibly fallen off during the past three or four weeks. The plate position also has become rather easier, although the tonnages passing into consumption are very large. Specifications from the shipyards continue on an extremely heavy scale and the busy conditions at the boiler, tank and wagon making establishments provide another big outlet. There is a persistent and increasing call for alloy and special steels from the armament and munition makers, and it is expected that business in this branch will remain at a high level for a long time. For several weeks activity at the sheet mills has been declining and the amount of new business coming forward has been disappointing. A very large proportion of the work in hand is on priority orders, and it is said that there is a probability that further large Government contracts will be given out in the not distant future. The whole of the Yorkshire steel industry is engaged upon Government business. The call for basic steel products may be less insistent than it was, but is still sufficient to keep the works fully employed. It is understood that considerable reserves of most descriptions of steel exist, but it is not likely that the position will enable the Control to release more steel for ordinary commercial purposes. There is an insistent demand for high-quality steels, including nickel steel and other special descriptions, but in the structural steel section many of the works are in a position to give fairly early delivery.

Copper and Tin

The British copper situation is practically unchanged. Large quantities are passing into consumption through the firms engaged upon war work, and there seems no lack of the metal for this purpose. Supplies for non-essential work are not so easily obtainable and there appears to be a tendency for the world copper situation to become tight. The arrangement made at the beginning of the war for Empire countries to supply the British war requirements have worked very well in practice and there seems little prospect of any shortage developing. In the United States conditions are stringent, but firms engaged upon the defence programme are receiving all the metal they need. The trade, however, is closely controlled by the authorities and, as in this country, there seems little surplus available for ordinary commercial work. The prices in the United States are unaltered at 12c. for domestic buyers and nominally 11·25c. for export, although in practice there is no export trade, since all available supplies are required for domestic purposes. Owing to the scarcity of shipping space there have been delays in obtaining copper for the United States from South American countries, but this seems to be rather a question of in what direction it is advisable to employ the shipping available. Canadian and African copper is reported to have been sent to the United States for refinement, the refined metal being shipped to Empire countries for war purposes. . . . Under present conditions there is little market for tin and the price of the metal has moved within a small margin. This is largely due to the fact that the price in the United States is controlled by the Metals Reserve Company, which buys at 50c. and has fixed the maximum selling price at 2c. higher. In this country the price remains at around £260 and when it falls below that level buying soon restores it. The variation seems to be principally in the contango, which moves to the extent of a few shillings.

Lead and Spelter

The lead situation remains steady and supplies reaching this country are adequate to fulfil the requirements of the war industries and to leave a small surplus for civilian purposes. Whilst the position in the United States cannot be regarded as easy, there seems little doubt that all the firms engaged upon work for the American Government are receiving full supplies and while there is some discussion as to the future position, there seems little likelihood of any real shortage developing. Consumption is on a heavy scale and it is estimated to be in the neighbourhood of between 80,000 and 90,000 tons per month. Although there has been no official statement regarding Russian requirements of lead, it is understood that fair quantities of British Empire lead have been shipped to the Soviet. . . . The tightness which characterised the spelter position earlier in the year seems to have become easier, but the Control continues to restrict the use of the metal as much as possible to essential work. Firms employed in the war effort, however, are receiving all the metal they require. In the United States the market is rather stringent and the price has not varied from the level of 7·25c., East St. Louis. According to the American Bureau of Metal Statistics, the United States exported 9185 short tons of spelter in June, 1941, the total for the first six months of the year being 35,715 tons. In June, 1940, 11,300 tons were exported and for the first six months of that year 31,450 tons. For the first six months of this year the United States imported 2700 tons from Canada and 7000 tons from Mexico.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

ENGINEERS' PRECISION TOOLS

Nos. 957, 958, 959—1941. These specifications have been prepared at the request of the Institution of Production Engineers and have been drawn up with the co-operation of the manufacturers and in close collaboration with the National Physical Laboratory. Like the previous specifications in this series, they relate primarily to standards of accuracy and performance and do not attempt to control details of design. The Standard for Feeler Gauges, B.S. 957, establishes permissible errors in thickness and parallelism and recommends those series of blades which may be combined together to form the most useful sets. The Standard for Precision Levels, B.S. 958, relates specifically to the type of level used in engineering shops for the testing and installation of machine tools and as used in tool rooms for testing the flatness of surface plates and tables. Recommendations are given regarding the sensitivities and the permissible errors in reading. An appendix to the specification gives useful notes on the choice of a suitable level and on the manner of using it.

Notes and Memoranda

Rail and Road

Southend Tramways.—The Southend Corporation has decided to abolish its tramway system and to replace it with buses and trolleybuses. The tram rails will be sold for scrap.

First American Concrete Paving.—Fifty years of continuous service by the first concrete street pavement in America were celebrated by the unveiling of an appropriate monument at Bellefontaine, Ohio, in June last. The four concrete pavements surrounding the court house in the centre of Bellefontaine were all laid in 1891 by G. W. Bartholomew.

Geneva Railway Junction Scheme.—Early this year the Swiss Federal Railways began work on a scheme for linking up the main Cornavin Station at Geneva with the Eaux Vives terminus of the French system on the opposite side of the Rhone. The *Railway Gazette* records that this brings to a head proposals which have been under way for more than seventy years.

Indian Railway Earnings.—The total approximate gross earnings of all the State-owned railways of India for the period ended April 30th, 1941, amounted to Rs. 314 lakhs, which is Rs. 14 lakhs more than the approximate gross earnings for the corresponding period of the previous year, and Rs. 10 lakhs more than the earnings for the corresponding period of 1940–41.

Manchester and Altrincham Electric Trains.—Electric trains are now running direct between Manchester (London Road) and Altrincham, on a time-table similar to that in operation before their suspension between Warwick Road and London Road. During the intervening period a service of steam trains was run to and from Manchester Central to connect with the Altrincham line electric trains at Warwick Road.

New Indian Ropeway.—Proposals are on foot for the construction of a ropeway linking Shimana with Panighata in the Darjeeling hills. The distance between the two places is approximately 14 miles, and the ropeway will be used principally for the purpose of importing goods from Nepal. It is understood that the Government has approved the project, which is estimated to cost Rs. 20 lakhs. Survey work in this connection will be begun shortly.

Diesel Traction in the Argentine.—Of the 12,500 kiloms. comprising the Argentine State Railway system 4532 kiloms., or over 36 per cent., are now served by diesel units. The number of railcars in daily operation over the different lines on December 31st, 1940, was 105. During 1940 the number of passengers carried by the three-car diesel sets between Buenos Aires and Rosario was 104,348, as compared with 89,075 in 1939, an increase of 15,273, or approximately 17 per cent.

Railway War Efforts.—On Monday last, September 29th, the Minister of War Transport, Lord Leathers, and Sir Alan Anderson, the Chairman of the Railway Executive Committee and Controller of Railways to the Ministry, made an extensive tour of the marshalling yards, despatch depôts, and wartime freight organisations of the Southern Railway Company. During the tour the Minister and Sir Alan had an opportunity of speaking with many railway men and women who had been decorated for gallantry during the air raids of last year. A large underground control room which dealt with the Dunkirk evacuation was also inspected. At the conclusion of his tour, Lord Leathers paid a high tribute to the very great efforts which the railway companies had made so far, particularly in combating all the attacks by the enemy and in restoring services after dislocation.

Air and Water

American Cargo Vessels for Eire.—The "West Hematite" and "West Neris," cargo ships of 8556 and 8542 tons respectively, recently left New Orleans for New York. The U.S. Maritime Commission has authorised the chartering of these two vessels to Eire for service between that country and American and Canadian ports. The ships are to be operated by Irish Shipping, Ltd., under the Irish flag.

Water Power in America.—The Federal Power Commission has recently stated that the entire capacity of water power plants in the United States and territories at the beginning of this year was 19,015,101 H.P. California, with a total installed capacity of 2,438,261 H.P., was first on the list; New York ranked second, with a total of 1,843,787 H.P.; and Washington was third with 1,214,504 H.P. The ten States with the next highest capacity are:—Alabama, 1,145,300 H.P.; North Carolina, 1,033,320 H.P.; South Carolina, 838,549 H.P.; Nevada, 708,830 H.P.; Tennessee, 694,406 H.P.; Maine, 637,527 H.P.; and Pennsylvania, 607,303 H.P. The largest net increases in the year were shown by Tennessee with 106,125 H.P.; North Carolina, 78,875 H.P.; Oregon, 72,875 H.P., which brought its total to 786,793 H.P.; Pennsylvania, 42,424 H.P.; and New Mexico, 34,390 H.P., increasing its total to 35,683 H.P.

Italian Ship Transfer.—It has been reported that the Italian steamer "Leme," of 8059 tons, will shortly be transferred to Great Britain under the Lease-Lend Act. She will be the first foreign ship to go to this country among those laid up at United States ports after being requisitioned by the Government. The Maritime Commission has so far requisitioned about sixty ships, all of which are now flying the American or Panamanian flags. Repairs are now being carried out in the "Leme."

Swedish Shipbuilding.—The Swedish Transatlantic Shipping Company recently added to its motorship fleet with the delivery by the Eriksberg shipyard of Göteborg of the "Yarrawonga," of 9050 tons deadweight. The ship, which is intended for the company's Pacific lines, is a combined cargo and passenger liner, and is propelled by a two-stroke, single-acting B. & W. Diesel engine of the yard's own make, developing 5400 I.H.P. The contracted speed is 14 knots. Another addition to the Swedish merchant marine is the motor tanker "Sveajarl," of 16,400 tons deadweight, delivered to the Svea Shipping Company, of Stockholm, by the Kockum shipyard of Malmö at the end of August. This vessel is a sister ship of the "Sveadrott," and is equipped with an eight-cylinder two-stroke double-acting Kockum-M.A.N. engine of 6000 H.P., which gives it a speed of 14½ knots.

Transatlantic Air Services.—Pan-American Airways, Inc., has announced the starting of the first transatlantic air express service between America and Europe. Shipments for Europe will not be accepted unless "air certs" have been obtained from British Consular officials declaring that no war contraband is included. The company has also been granted permission to establish a service between Florida and South-West Africa, operating *viâ* Puerto Rico, Trinidad, and Brazil. The authorisation expires in five years, or six months after official notification that the service is no longer required for national defence. A new channel for supplies to aid Empire Forces in the Middle East has been opened as a result of an agreement under which Pan-American Airways will ferry American-built warplanes from America to Khartoum. From New York they will fly *viâ* Porto Rico, Trinidad, Port Natal (Brazil), Monrovia (Liberia), or else from Bathurst (Gambia) to Lagos (Nigeria). An extension to Leopoldville (Belgian Congo) will enable connection to be made with Belgian and South African air lines which serve South Africa, Uganda, and Tanganyika. The Pan-American Company is also to establish a service between West Africa and the Middle East which will connect up with the new American line from the States to West Africa.

Miscellanea

U.S.A. Magnesium Output.—The Dow Chemical Company expects to produce 30 million lb. of magnesium before the end of 1941, whilst early in 1942 its annual capacity is expected to reach 52·5 million lb. Another producer is the Chemcal Engineering Division of the Todd-California Shipbuilding Corporation at Permanente, near San Jose, California. This concern hopes to have its plant in operation shortly, and is looking for an annual capacity of 24 million lb. of magnesium next year.

India as an Arsenal.—It is expected that 1941 will mark the production of 3000 armoured cars of all-Indian manufacture. They are for the eighty-five new motor transport sections of the Army. An additional 25,000 vehicles a year are to be assembled at the Indian plants of Ford and General Motors. War planes should soon be coming out of the factory erected at Bangalore by the Indian Aircraft Company. Shipyards in Bombay and along the Hooghly (Bengal) are busy building naval merchant vessels.

State Bursaries for Science Students.—To meet the demands of the Services and industry for technical officers, the Board of Education has established a scheme of State bursaries tenable at universities and at certain technical colleges by boys and girls who have reached the required educational standard. The demand is particularly pressing for radio work, for which physics is essential, but others will be required for posts needing qualifications in engineering and chemistry. Full details can be had from the Board of Education, Branksome Dene Hotel, Bournemouth.

Manchester Association of Engineers.—The Constantine Prize has been awarded to Mr. O. Rendell for his paper on "Line Production of Machine Tools," and Mr. S. N. Brayshaw has been awarded the Butterworth Prize for his contribution to the discussions during the session 1940–41.

Personal and Business

Mr. G. Voelkner has been appointed general manager of the Lehigh Valley Railroad, in succession to Mr. J. N. Haines.

Mr. John Green, a local director of Thomas Firth and John Brown, Ltd., has joined the board of the Iron Trade Employers' Insurance Association, Ltd.

We note with regret the death, on September 25th, of Mr. Maurice Deacon, M. Inst. C.E., M.I.E.E. He was associated with several colliery companies as director and consulting engineer, and was a Past-President of the Institution of Mining Engineers.

Mr. Norman N. Bird has been appointed manager of the Bridgewater Department of the Manchester Ship Canal Company, in succession to Mr. T. Rylance Hague, who has retired. Mr. Bird will also act as *liaison* officer and secretary of the North-Western Regional Canal Committee.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that in order to make sure of its insertion he necessary information should reach this office on or before the morning of the Monday of the week preceding the meetings. In all cases the time *and* place *at which the meeting is to be held should be clearly stated.*

Institute of Transport

Monday, Oct. 13th.—Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Presidential Address, J. S. Nicholl. 5 p.m.

Institution of Chemical Engineers

Friday, Oct. 24th.—Institution of Civil Engineers, Great George Street, S.W.1. "Scientific Knowledge and Action," Sir Richard Gregory. 2.30 p.m.

Institution of Electrical Engineers

Wednesday, Oct. 8th.—S. Midland Students: Watt Memorial Institute, Great Charles Street, Birmingham. "Telecommunications of the Future," W. G. Radley. 6.30 p.m.

Monday, Oct. 13th.—N.E. Centre. Neville Hall, Westgate Road, Newcastle-on-Tyne. Chairman's Address, R. W. Gregory. 6.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Oct. 14th.—39, Elmbank Crescent, Glasgow. Presidential address, F. C. Stewart. 6.30 p.m.

Institution of Mechanical Engineers

Friday, Oct. 24th.—Storey's Gate, Westminster, S.W.1. Presidential Address, "The Position of the Locomotive in Mechanical Engineering." W. A. Stanier. 2.30 p.m.

Iron and Steel Institute

Saturday, Oct. 4th.—Royal Victoria Station Hotel. Joint meeting with the Sheffield Society of Engineers and Metallurgists and the Sheffield Metallurgical Association. 2.30 p.m.

Wednesday, Oct. 8th.—Engineers' Club, Albert Square, Manchester. "The Polishing of Cast Iron Microspecimens and the Metallography of Graphite Flakes," and "The Metallography of Inclusions in Cast Irons and Pig Irons," H. Morrogh. 4.30 p.m.

Junior Institution of Engineers

Saturday, Oct. 4th.—39, Victoria Street, S.W.1. "Epidiascopes in General—the J.I.E. Epidiascope in Particular," H. J. N. Riddle. 2.30 p.m.

Saturday, Oct. 18th.—39, Victoria Street, S.W.1. "Fire Fighting and the Engineer," J. W. Stenson. 2.30 p.m.

Keighley Association of Engineers

Wednesday, Oct. 8th.—Victoria Hotel, Keighley. "Some Problems of Mechanical Flight," S. F. Benson. 7 p.m.

Manchester Association of Engineers

Saturday, Oct. 11th.—Engineers' Club, Albert Square, Manchester. Presidential address, F. Carleton. 2.30 p.m.

Manchester Geological and Mining Society

Tuesday, Oct. 14th.—Queen's Chambers, 5, John Dalton Street, Manchester. "The Volumetric Method of Testing Mine Dust Samples," E. H. Browne. 2.45 p.m.

Newcomen Society

Wednesday, Oct. 8th.—Chartered Institute of Patent Agents, Staple Inn Buildings, W.C.1. "The Development of the Practice of Evaporation," N. Deerr and A. Brooks; and "Automobiles in 1830," S. Withington. 2.30 p.m.